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The American Standards Association is organized to provide systematic means of cooperation in establishing American Standards to the end that duplication of work and the promulgation of conflicting standards may be avoided; to serve as a clearing house for information on standardization work in the United States and foreign countries; to act as the authoritative American channel in international cooperation in standardization work

Safety Standards for Automobile Construction and Maintenance[1]

by

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An analysis of causes of accidents due to faulty construction, design, or maintenance, and proposals for improvements

In this "age of standardization", when so many business interests are competing in the manufacture and sale of products which purport to be the same, it is necessary that the whole field be surveyed in order to determine where standards can be of greatest benefit. It is obvious that if a "standard" can be established which will save the lives of thousands as well as benefit financially millions of purchasers and hundreds of business interests it will be doubly valuable.

Traffic accidents show a new field for standards —A detailed recital of traffic accident statistics is unnecessary to show the unbalanced condition which exists in automobile transportation. The mere fact that some 35,000 persons were killed, over a million were injured, and an economic loss of $2,500,000,000 was sustained last year due to accidents is sufficient to show the actual severity of this situation. When it is learned that these deaths and injuries occur at a greater rate than those produced by war, or by any disease except heart-failure, and that the economic loss was four times the fire loss, was more than the entire cost of public education, or the amount of money which motorists paid for new cars last year—then its *comparative* importance is evident. If standardization can improve this situation, efforts to realize it should be made at once.

The design and maintenance of the vehicle as a cause of accidents—The driver, the vehicle, and the roadway are the three factors any one or all of which are contributors to almost every accident. While it is possible to blame the driver for all accidents—to say that he should recognize roadway hazards and drive accordingly, or that he should keep his car in safe condition, or drive more slowly when it is not in good condition—this is not a practical answer. Human nature is not infallible and there are many things involved which control it to a considerable extent. To give a motorist a smooth, flat, straight roadway over which he can drive comfortably at 60 miles per hour, and then to tell him to drive 40 on the open stretches and 25 or 15 miles per hour at the intersections because the design of the roadway does not provide safety at a speed of 60 miles per hour and because of the presence of other vehicles and pedestrians, is to court disobedience and accidents. To give a motorist a car which is advertised to go at 75 miles per hour (and incidentally this is one of the places where truth in advertising does exist) and to ask him to drive within the speed limit is again to court disobedience and accidents. To give a motorist smooth roadways and fast cars and to depend upon him to keep the safety equipment in good condition without continually cautioning him and checking up on him is a third way of courting lawlessness and disaster. These influencing factors of roadway surfaces and cars capable of comfortable and economical high speeds, plus the natural apathy and laziness shown by the average owner in giving his car any attention as long as it runs, must always be seriously considered. Human nature has cracked under the strain and our accident toll is the result. These three factors can be improved, however. Roadways can be designed to make the comfortable and current speeds safe. The vehicle can be kept in a safe condition by periodic inspection.

Now just how much of a contributor to accidents is the mechanical condition of the car? The trouble in establishing this fact is that the actual accident records show only about 15 per cent of the accidents attributable to mechanical failures. By this figure the motorists and many safety engineers have been argued into feeling that the vehicle itself is not very important and that most of the effort should be put upon the individual and the roadway. But the accident records are not telling the whole truth. First,

[1] This article includes parts of a report made by Mr. Halsey to the Society of Automotive Engineers in January, 1932.

because no operator is going to state on his accident report form that "his brakes were faulty", since that would admit negligence. Second, because there are not enough policemen or inspectors to actually investigate the accidents. Third, because most accident investigations in the past have not covered mechanical equipment; and fourth, because many of the vehicles involved in accidents are so damaged that it is impossible to tell the condition of the equipment prior to the accident.

The fact which really shows the importance of the mechanical condition of the vehicle is the surprisingly large proportion of existing equipment which past motor vehicle inspection campaigns have shown to be defective and unsafe. When the records show that as many as one-third of the brakes were in such a condition that they would not stop the cars in the distance required (less than the average car in good condition will stop) and that as many as one-half of the lights were imperfect, it is immediately apparent that far more than 15 per cent of the accidents could have been prevented if this equipment had been in good condition. Try to visualize the accidents which could have been prevented if the operator had been able to stop just a little more quickly or had been able to see a little better. It would certainly seem that at least one-third of the accidents could have been prevented or materially reduced in their severity if the design and maintenance of the vehicle had been improved.

Defective mechanism	*Number of accidents*	*Number of persons killed*	*Number of persons injured*	*Approx. amt. of property damage*	*Type of Accident*		*Dir. of Movement*	
					Collisions	*Fixed objects*	*Straight per cent*	*Turns per cent*
Defective brakes	117	3	87	$16,600			65	35
Defective steering gear	60	1	62	$ 8,750			50	50
Punctures or blowouts	52	2	48	$ 7,700	40	60	85	15
Glaring headlights	40	1	49	$ 5,800	80	20	80	20
Both headlights out	27		20	$ 4,100	96	4	70	30
One headlight out	11	2	9	$ 1,900	82	12	82	12
Tail light out	27		18	$ 4,550			50	
Skidding	34	3	34	$ 3,300			50	50
TOTAL	368	12	327	$52,700				

TABLE 1

Accidents in Pennsylvania during the month of November, 1931, due to defective equipment

Whereas in the past the operator has been held responsible for most accidents and comparatively little attention has been paid to the accident potentialities of roadways and vehicles, to solve the problem adequately proportional attention must be given to all three factors. There is no point in tempting fate by expecting the operator to make allowances for roadway and vehicular defects which can be removed.

Table 1 shows the accidents in one state for one month due to mechanical defects.

Progress in any field can be made only if time, energy, and money are concentrated on those items which are the farthest behind and need the most attention. At the present time some factors of automobile and highway design are far ahead and others far behind and it is this disparity which causes many of our difficulties. The present mobility or speed of cars, for instance, is far in excess of the ability of roadways to care for it or of present-day drivers to handle it with safety. In addition, the potential speed of cars today is far ahead of their inherent safety—when the limitations of human nature and ability are considered.

Improvement in the industry—The automotive industry, which is but some 25 years of age, has made tremendous strides in improving the vehicle. It has been very sensitive to the demands of the public and has materially improved the comfort, convenience, and mobility of its product. In fact, it has been so successful along this line that it has

far outstripped the growth of facilities necessary for its use. Available roadway surface, traffic control, parking facilities, and a class of drivers able to use these effectively, safely, and expeditiously are still far behind.

To merchandise cars the manufacturer has had to meet demands for certain characteristics of design, but he has wisely insisted that the demands exist before he set about fulfilling them. He has recognized the demands for comfort, convenience, and speed, and is to be congratulated on his fulfillment of these. But now a new demand is arising—that of safety.

If in one state for one month vehicle defects cause 368 accidents which result in the death of 12 persons, the injury of 327, and the demolition of property to the extent of $52,700 then the national total for a year must be considerable. While it is not entirely feasible to build up national figures on the basis of one state still the results will show a situation which is just as apt to be right as wrong. In this one state, which had approximately 46,047 accidents in 1931, 8 per cent may have been due to mechanical defects. This would give a total of 3,600 accidents, over 120 fatalities, 3,300 injuries, and a property damage loss of over $500,000.

These extended to the country as a whole give 95,000 accidents due to mechanical defects, which would kill over 3,000 people, injure 85,500, and cause over $13,000,000 worth of damage, an obvious reason why automobile insurance rates are high and are going higher.

These sample figures, while they cannot be proved correct—or incorrect—show the potential picture. Let us now consider some of the characteristics of automobiles which undoubtedly are partly responsible for this result—and indicate some of the possible methods of improvement.

The rest of this paper will deal with some of the positive constructive steps which the industry can profitably make in reducing accidents—the safety improvement of the vehicle and its preparation for withstanding accidents, which are increasing in number and severity.

Some improvements foster new hazards—While the manufacturer has not recognized the safety demands generally, he has acknowledged certain specific ones and has made improvements to meet them. Unfortunately some of these improvements, while they reduced one particular hazard, fostered changes in driving characteristics (such as higher speeds) and thus brought about new and different hazards. Better brakes, improved headlights, a lower center of gravity, and the higher comfortable economic speeds of even the lower priced cars have provided more of a temptation than human nature can withstand—and speeds have increased. This increase in the average speed has thrown an additional burden upon the manufacturer and has tended to greatly magnify the importance of safety construction. Thus for every improvement which permits greater mobility the manufacturer must increase still further the safety devices of the motor vehicle. In fact, the improvement of safety devices must be greater than the increase in speed or it will not offset it. As speed increases, additional braking distance for each mile per hour is necessary because the demolition or impact factor increases at a greater rate than does the speed, and because the reaction time, and probably the general ability of the individual motorist, remains about the same.

Selfish interest of manufacturer in safety—In this economic civilization of the Twentieth Century, safety cannot be sold upon a humanitarian basis, no matter how strong the case may be. There must be a dollars and "sense" basis—and there is. The sales of any product are in direct proportion to how much its advantages offset its disadvantages. As the disadvantages increase they must be eliminated or the sales will drop off and another product will be bought or used.

Accidents and the resulting economic loss, delay, and inconvenience are a definite sales resistance to the industry. A national economic loss due to accidents of $2,500,000,000 and of $5,000,000,000 due to congestion preempts a lot of money which might otherwise go into more automobiles. How many potential car owners do not buy cars because of high insurance rates, or because they are afraid to let their wives and children drive, or because in many large cities they can go more quickly and with less irritation by some other means of transportation, or because they cannot find a place to park?, There are probably thousands, and their number will increase as accidents and congestion increase until a marginal point is reached where more money will go into other elements of pleasure and convenience.

The industry should not disparage or minimize the accident situation, as evidences would tend to indicate that they have. The growth of accidents is natural and inevitable when viewed in the light of the unbalanced development of the factors involved. It cannot be stayed by ignoring it. The industry has apparently felt that to call attention to the seriousness of the accident situation would be to discredit the automobile. But "murder will out", and other organizations have already done it for them. Sweeping back the ocean with a broom would be easy compared to "standing by" and trying to give the impression that "conditions really are not very bad".

The better premise is that the condition is already upon us and that "the industry will do everything possible to improve it and will provide as many safety features as possible". Here is a real popular demand which can and should be used to great sales advantage. There have already been some excellent examples of this in the change from speed advertising to safety advertising. Non-shatterable glass, stronger tops, lower center of gravity are tending to make motorists safety conscious and the industry should step in and take advantage of it to sell more cars.

There are many safety activities in which the industry should join because they are a business aid to it. Good examples of this are the "motor vehicle inspection campaigns and laws". Initially the industry may have felt that the annoyance of these inspections would reduce sales. They may have overlooked its effect on one of their greatest problems—used cars. Rigid inspection several times a year, as is now being done in several states, should remove thousands of unsafe used cars from the highway and thus make room for more replacements. Since but 28 per cent of the money expended is for new cars and 72 per cent or $8,574,000,000 for repairs, parts, supplies, labor, and accessories, the dealer should be vitally interested. Such safety movements mean a definite financial gain to the industry and the dealers. A reduction in accidents and congestion cannot help but make the automobile more attractive as a personal unit of transportation, and it will prevent its potential users from adopting other forms of transportation. Thus the automobile manufacturers should take a farsighted view of the situation, take positive steps toward safety, and cash in on the demand which is growing and which cannot be stopped by denying its existence.

The case for the car buyer and owner—At present the car buyer is forced to base his choice upon his own personal opinion or upon advertising and sales arguments, either of which is entirely inadequate. If minimum safety standards were set he would at least receive some protection and would have a "base" from which to measure competing products.

The car owner is faced with the maintenance problem. In this he is affected to a considerable extent by the way in which the manufacturer has designed his product. The easier and less costly the product is to maintain in a safe condition the greater the length of time the operator will keep it in that condition.

Making the vehicle safe—At the present rate of accidents involving injuries, some 1,000,000 during last year, the manufacturer should expect that each car he sells will eventually be involved in one or more accidents. Since it is admitted that the human element is the greatest factor in automobile accidents, he should improve those things which bolster up the abilities of drivers and overcome their deficiencies. Since the motor vehicle inspections, improved by the use of permanent inspection stations and more frequent inspections, have frequently shown that as many as 50 per cent of the brakes and 66 per cent of the headlights were out of adjustment, the manufacturer should endeavor to make his vehicles as easy to maintain and as automatic in adjustment as possible.

For the purposes of discussion the elements of safety will be taken up as follows: *First*—The operator should have adequate visibility, steering, and deceleration. *Second*—He should be able to keep his wheels on the ground and should not be distracted by the operation of his car. *Third*—He should be be able to give visible signals, should receive plenty of fresh air, should be comfortable, should be protected against fire, and in case of an accident, should be protected by the car body from as much damage as possible.

These will indicate what items should be considered in establishing standards.

Visibility

It is obvious that the ability to see and to be seen is most important in preventing accidents. At modern speeds to lose track of approaching traffic for a few seconds frequently results in accidents. And yet there has probably been less attention given to this than to many other safety features of the automobile. Let us first consider the visibility of traffic conditions from the driver's seat.

Location of driver's head and eyes—The exact position of the driver's eyes in the car must be used as a basis for determining his visibility. To say that the driver can move his head and thus look around obstructions is not sufficient, for while he can, you may be quite sure that he won't. He will drive right on until something comes into his existing field of vision.

Obstructions to view—The tendency to have motorists sit lower in the car frequently means that the driver's eyes are almost as low as the cowl with the result that he cannot see his fender or any object within 10 feet of the car. This situation can probably be improved by lowering the cowl and by lowering the steering wheel so that one can see over it, or by reducing the size of the rim and the number and size of the spokes. Another horizontal ob-

struction, particularly for tall motorists is the sun visor. This situation has recently been improved by moving it inside the car and making it adjustable.

The pillars which support the windshield are a common vertical obstruction which can be materially reduced. A difference of one-quarter of an inch in width, when close to the driver's eye will increase the blind spot at 50 feet by several feet. Top supports come in almost the same category, although visibility behind the front seats is not needed as frequently as in front and there are probably more structural difficulties involved. This situation can be definitely improved by adding additional footage of glass from the driver's seat back.

Clear windshields are obviously necessary. The method of mounting is probably responsible for many cracked windshields which soon collect dirt. Some of the earlier "non-shatterable" glass apparently leaked air around the edges and caused discoloration. Windshield wipers have improved, and when two are used fair visibility results. However, there still remains a possibility of devising a simple mechanism which will clean a greater amount of space.

Snow, sleet, and ice removers which can be counted upon to work effectively are still to be found. The amount and application of heat necessary to do the work in spite of the differences of temperature inside and out make the problem very difficult.

Competitive light interference—One of the most serious interferences with vision is the refraction of light from outside sources through the windshield, side and rear glass. This has been quite successfully dealt with in front by slanting the windshield. It is quite apparent that the side and rear windows will eventually have to receive the same treatment.

The dash lights still offer some competition even in the best designed instrument boards. It is suggested that the use of "position reading" instruments with only the arrow and numbers illuminated may be of some assistance in reducing the glare. It is also not beyond the realm of possibility that many of the instruments can remain dark until the arrow reaches a dangerous point. Thus eventually we may find that such instruments as the engine heat indicator, the ammeter, the gas, and the oil gauges will automatically light up when the arrow gets to the point when it requires attention on the part of the motorist. The speedometer, on the other hand, should be constantly and adequately illuminated at night so that it can be read quickly.

The effective reduction of headlight glare can only come from improvements in the headlights themselves and will be discussed later.

Assistants to visibility—Headlights which provide adequate side lighting and a long beam which does not glare are of great importance at night. The side lighting has been effectively improved in some cars, but the "distance throw" without glare has not yet been produced. There are some lights which do have a sharp "cut-off" but even these are subject to glare because of bumps in the road or because of poor adjustment. It is suggested that the assembly be made such that it is impossible for the headlights to get out of adjustment to the extent of throwing the beam above the horizontal. It is also possible that the headlight units could be mounted in such a way as to automatically compensate for bumps in the road or heavy loads in the back seat. The vertical location of the lights may come in for some intensive study due to the fact that the heads of drivers are coming closer and closer to the surface of the road. Human nature is such that it is rather doubtful if motorists will add to their driving habits that of dimming their lights for each vehicle which approaches. Driving a car for long distances requires a sufficient number of manipulations as it is and approaching cars are too frequent.

Spotlights have a valuable function in night driving—that of indicating the outside edge or shoulder of the highway. This is particularly valuable during

Secretary of Commerce Chapin, new general chairman of the Conference, came into the meeting and expressed great interest in the Conference work. He stated that the need for uniform motor vehicle laws is self-evident and believed that the uniform standards developed by the Conference in cooperation with other agencies provide an invaluable basis for such uniformity. He commended the greater attention now being paid in many states to the condition of the motor vehicle but felt that there should be still greater activity in protecting users of the highways against vehicles in unsafe conditions. To his mind, control of the driver through the license system and check on the mechanical condition of vehicles through periodic inspections are two of the outstanding needs.—*From the minutes of the meeting of the Executive Committee of the National Conference on Street and Highway Safety held in Washington, October 7, 1932.*

fog, snow, or heavy rain. They can be located very low and shielded so that they produce no glare at all. It is entirely possible that this function may be incorporated right into the headlight so that a spot may be automatically thrown where the driver needs the light.

In exceedingly low cars, where the driver has difficulty in seeing his fenders, indicators have been developed to show him just where the outside of his car is. These sometimes serve a second function of indicating the outline of his car to approaching motorists.

Rear vision mirrors still leave many blind spots behind the car as many a motorist arrested for speeding has discovered. The mirror in the center is adequate for a straight view behind, if it is located properly and if it is in line horizontally with the rear window, and if none of the passengers are in the way. Even then, however, it will not indicate the overtaking vehicle which is about to pass on one side or the other. The fender or door-hinge mirror is of some assistance for this purpose but with the increased width of rear seats even it is becoming ineffective. It is quite possible that a compound mirror or an actual telescope will be developed for closed cars. The craning of neck is exceedingly unpopular—in fact, it is seldom done and the motorist goes blindly ahead and not infrequently becomes involved in an accident. Let us now consider the visibility of the vehicle from the outside.

Headlights—The headlight has several functions which it must serve in addition to illuminating the road. It should indicate the outline of the car for the benefit of approaching motorists. Its present tendency to glare and its location prevent it from doing this at the present time. It should also provide side illumination so that the vehicle can be seen by cars approaching from the side. Here again it fails at the present time.

Side lights—The introduction of fender lights has served the purpose of indicating the outline of the car and of providing side illumination. Aside from the artistic value of such units, it is possible that the same result might be obtained by a redesign or relocation of the head and tail lights to serve as side lights.

Rear light—The rear light has been assigned numerous jobs, chief among which is to advise motorists approaching from the rear of the car's presence. It is felt that greater illumination is needed than now exists, due to the fact that motorists do not clean the glass frequently enough. The side and license plate illumination are also in need of improvement.

Reflecting lights—Comparatively recently a type of reflecting glass has been developed which is now being used to replace the tail light and cowl light lenses in many of the cars. When the bulb is lit an adequate amount of light is thrown out. When the bulb burns out the glass will provide adequate illumination by reflecting approaching headlights up to one or two hundred feet. This glass provides automatic protection in case of bulb failures and is now required on all cars registered in the State of Colorado. Several other states require it on the rear of trucks and buses. This is the sort of automatic protection with which the industry should provide the motorist. It should be assumed that he will be too lazy or forgetful to check his lights frequently enough. It is quite possible that reflecting glass will be used to indicate the outline of the car and to provide side illumination. This should mean quite a saving to the manufacturer and would relieve the headlight and tail light of these duties. The Society of Automotive Engineers has already adopted a standard for reflecting elements. It would be an excellent step toward safety for the motor vehicle commissioners to adopt these in their regulations and thus cooperate with the car manufacturers.

Telltales—Since the motorist is too lazy to check his lights it might be advisable to provide him with telltales so that he will at least know without having to get out of his car which lights are on and which are out. Some headlights have been provided with pencils of glass or apertures which show whether or not they are on. At one time on some cars the tail and dash lights were in series to show whether they were both in working order or not. The author has resorted to a 21 candle power stop light so that by watching the needle in the ammeter he can tell whether or not his stop light is in working order.

Parking lights—One of the reasons why motorists hesitate to leave a light on their parked cars is because the wiring is such on many cars that in order to get the tail light on it is necessary to have two cowl lights and two dash lights on. These five lights represent a considerable drain on the battery. Either the wiring should be changed or an additional switch or light provided.

Headlights versus highway lighting—There has recently been considerable agitation regarding highway lighting. It is apparent at the outset, however, that its cost will restrict it to the metropolitan areas and the more important trunk lines. Elsewhere it

will probably prove more economical to light the highway only when cars are actually using it. Thus it is evident that there is a definite demand for improved headlights with more light on the road, better side lighting, and a considerable reduction in glare.

Steering

Second in importance to visibility is the ability to control the front wheels. Here again the change in driving habits has come into play. Higher speeds and women drivers who have less physical strength than men have placed additional burdens upon the steering wheel. Let us first consider the operation of the steering mechanism by the driver.

Guards against failure—At no other place on the automobile, with the exception of the wheels, are lock washers, cotter keys, and other safety devices more important. Where ball and socket joints are used, special care should be taken in design so that normal wear will not let the ball out of the socket. If possible, some arrangement might well be made whereby it would be impossible to completely assemble the unit unless the locking devices were properly applied. One should not rely entirely upon the mechanic. The dangerous part is that failures are most apt to occur in an emergency when the maximum pressure is put on the steering mechanism.

Ease of steering—The steering of a vehicle must be made very easy for the motorist, otherwise he will do as little of it as possible. By this it is meant that the motorist will be reluctant to pull over and let others pass, he will be inclined to ride in the center of crowned roads, and he will take wide swings on corners—because it is easier. It would appear that the problem of leverage and the angle of the wheel to the driver should be given further consideration.

Ability to swing wheels quickly—In trying to provide ease of steering the gear ratio was increased on some cars. This meant that to swing the wheels quickly, one or more entire revolutions of the steering wheel were necessary. This manipulation required just a little more agility than the average driver possessed. Thus the ease of steering must be obtained by some other method than gearing down the steering wheel.

Power steering—There are already several "booster" devices for steering today. Some work by vacuum, others by oil pressure. They have an immediate application on heavy trucks and buses and eventually may find their way into passenger cars, particularly of the heavy type, because of the comfort and convenience which they provide. The principle now in use of using the power indirectly as a booster and of keeping the normal manual connection appears to be a good safety measure. With power steering the problem of quick turning is easily solved because the wheel does not have to be geared down for steering ease.

Automatic straightening of wheels—The new models appear to have the characteristic of self-straightening rather highly developed. It is of some assistance and convenience to the motorist.

Let us now consider some of the other elements of steering.

Interference with steering—Obviously the steering mechanism should be protected from any failure of other parts of the car—there should be no inherent faults of design. For example, it is my understanding that there have been and still may be cars so designed that the breaking of one or both front springs will permit the chassis of the car to drop down and lock the steering mechanism so that the front wheels cannot be turned.

Another danger is that road shock or "fright" has undoubtedly caused many a motorist to lose control of his car. While the dangerous consequences of this have been lessened to a considerable extent by the development of the so-called "non-reversible" steering mechanism, there are still cars being sold which give a considerable kick-back.

The operator's compartment should be designed in such a manner as to assist him in his operations and not to interfere with them. If it is assumed that maximum steering efficiency can be obtained if the operator is directly behind the steering wheel, then that position should be made comfortable for him. The widening of the front seat to admit three people has tended to force the driver to the left of the steering wheel—if he is to find an arm rest and desires to lean up against the side. It might be possible to make the side of the compartment, as well as the back, adjustable.

Many operators have run into difficulty because of insufficient clearance around the outside of the wheel from the windshield, cowl, door, gearshift lever, and the individual himself. At high speeds the hazard of having your hand or elbow jammed, even momentarily, is quite obvious.

Other serious interferences with steering are projections which catch the sleeve of the operator when he is about to make a turn. There appears to be no logical or economical reason why the window and door handles cannot be so located and designed as to make this impossible, and still not interfere in

the least with opening and shutting the door or window. Light, gas, and spark levers mounted on the steering post are also sources of interference. The light levers are probably the worst offenders because at night they are not only apt to catch the sleeve and interfere with steering but at that crucial moment they may also turn out the lights. Furthermore, they provide a dangerous place into which one of the operator's thumbs or fingers can become wedged. Is there any reason why levers or switches of the "counter-sunk" variety cannot be used?

Braking

Braking is perhaps the next most important feature of the automobile. It is the factor which has probably been hit the hardest by our increased speeds and it has been natural that the stopping distance for greater speeds has gone up. This condition, however, has undoubtedly increased the hazard. The "safe approach" speed to any intersection, curve, or hill where the visibility is obscured is simply a question of how far you can see and how soon you can stop. For example, if you are approaching a blind intersection where you cannot see a car coming out of the cross street until you are within 50 feet of it, you cannot safely approach it at a speed higher than will permit you to stop with 50 feet. At the old speeds of 25 miles per hour at such points it was possible to stop, but at the new speeds of 30-40 miles per hour it is not—at least not with present braking equipment. The frailties of human nature are such that as comfortable economical cruising speeds have gone up the motorist has taken advantage of them and has failed to slow down at such dangerous points. Now while that is a human failure for which the vehicle is not responsible, still it indicates a demand for mobility and the industry should try to help the motorist by giving him all the braking power possible and thus increasing his "safe approach" speed. Let us now consider the operation of the brakes.

Operation—The first principle of operation should definitely be that of positiveness. The linkage system should be so designed that it cannot become jammed, frozen, or interfered with in any way. This is particularly important on trucks where a heavy load may change the angle of the brake rods and reduce their effectiveness.

There should be a definite correlation between pedal pressure and braking distance for different speeds. Minimum standards should be set. It is not reasonable to design a car so that only the strongest group of motorists can get adequate braking distances. The recent series of tests indicated the wide variation among various makes of cars. A braking system will eventually be demanded and paid for by motorists which will not depend upon the strength of their right feet.

The fact that there is still no definite unanimity of opinion as to what proportion of the braking power should be applied to each end, in order to compensate for the fact that the weight of the car is shifted to the front when brakes are applied, indicates that there is still a demand for further research along this line.

Equalization is still not satisfactory and there are many cars which pitch to one side or the other when brakes are applied at high speed.

One of the greatest demands on braking in an emergency is that of preventing locked wheels and skidding. The locking of wheels is still left to the discretion of the operator. The natural reaction in case of an emergency is to jam on the brakes, and this produces skidding and an increase in the braking distance at higher speeds. There is a fundamental principle in traffic control and in automobile design and that is to take away from the motorist as much discretion as possible. The automobile should be so designed that the motorist has only to indicate to it the action and degree of action which he wants and it will automatically be taken care of for him. A step in this direction has already been taken by the coordinating of the braking power with the motion of the wheels so that as the wheels slow down the available pressure is reduced.

The locking of front wheels, which prevents turning, is another important difficulty. Here again steps have been taken to reduce the pressure on the front brakes whenever and to the extent that they are turned.

There have been quite a few accidents due to the locking of brakes, although most of these have occurred at railway crossings and involved the emergency brake handle. It should certainly be possible to design a brake handle so that one motion puts it on and the reverse unlocks it and releases the brake.

The location of brake levers is a problem which still needs attention. The foot brake lever needs a guide so that the motorist's foot does not slip off of it in an emergency. In most cases it is quite near the steering post and this might be used as a guide. As the steering post tends to slant more and more toward the operator the brake and clutch levers might be made to slide down it in grooves and a straight line push obtained—if this would prove advantageous and the necessary linkage would not offset the advantage. On one new car the panel between the engine and the front seat bulges out so that unless the foot is placed on the pedal ex-

actly right it cannot be pushed down all the way.

The relationship between the location of the foot brake lever and the accelerator might receive further study in order to prevent accidents caused by the motorist's foot slipping from the brake to the accelerator. A raised edge in the foot brake—collapsible if necessary—might be of some assistance. The location of the hand brake has always been difficult. The two most inconvenient and dangerous difficulties are, first, that the driver has to reach too far and too low to get a quick grip on it, and, second, that when it is partway back it is in a hard position to pull or that your hand tends to slip off it. If three people are in the front seat it is hard, if not impossible, to get hold of present emergency brakes. If it is presumed that the emergency brake is only to be used in case of the failure of the conventional foot brake system, and I believe that this is a fair assumption under present equipment, then why would it not be feasible to provide an additional foot pedal which could be reached much more easily? If necessary it could be used by the left foot, would automatically throw out the clutch, and could be made to lock down for a parking brake. It could be located so that it would not be in the way nor be confused with the clutch pedal. Another alternate would be a hand brake more nearly shoulder high—where it could be reached with three in the front and where a much stronger pull could be obtained. I am aware of the difficulties involved in the use of cables or multiple levers, and yet much can be done to improve the location of pedals and levers.

The increase of speed, coupled with the fact that the slow or dangerous points have remained about the same in number, has required more braking and thus more wear. In a depression and in a highly competitive market it is easy to understand why individual companies do not install brakes that would outlive the car. The companies should, however, provide braking surface and cooling facilities sufficient for sustained grades.

While the motor vehicle equipment inspection campaigns showing that about 50 per cent of the motorists fail to maintain their brakes in a safe condition tend to give the manufacturer a good out, still there is much that he can do to make them easier to maintain and to keep them in good condition for longer periods with less attention. Improvements in waterproofing and provision for draining out whatever water leaks in would be advantageous. Better packing on rear axles to prevent oil from leaking on them is needed. Gravity drop devices to take up the slack automatically might be of assistance. A general simplification of braking systems and a reduction in the number of parts would make maintenance easier and reduce the price of adjustment and repair to a point where they would be sufficiently attractive to the motorist to have him use them more.

High speed heavy commercial vehicles should have the same braking distances as passenger cars. The more weight there is in motion, the more damage it can do. In the larger units this brings us inevitably into power braking, using compressed air, vacuum, oil pressure, or the power of the drive shaft. It should be entirely possible by such measures to materially increase the stopping power of commercial vehicles. Where trailers are involved, their brakes should be controlled from the cab of the powered unit and should be so designed that if the coupling breaks they will automatically be set for an emergency stop. I believe that some states already require this by rule or regulation.

The so-called emergency brake, on most cars at least, has turned out to be a parking brake. With brakes on all four wheels the possibility of both the front and rear sets becoming inoperative at the same instant is rather remote. The foot brake has almost always had more stopping power than the hand brake. In addition, in case of emergency, it takes too much time to get the hand brake on. Thus the hand brake may simply become an additional linkage system so that, if either the front or rear set fails or the foot pedal linkage system fails, the hand lever may take its place. It is obvious that unless the front and rear brakes can be operated independently—through the linkage system—an emergency brake must be provided through an additional drum or drums either on the drive shaft or on one set of wheels.

Free wheeling—The provision for coasting in an automobile without the necessity of throwing out the clutch manually has undoubtedly had a material effect upon driving characteristics and braking systems. The Eastern Conference of Motor Vehicle Administrators recognized this and made a decision prohibiting any form of free wheeling which made it impossible for the motorist to get his car into positive "conventional gear". The motor is undoubtedly an assistance in stopping and they probably felt that there were few, if any, cars which had sufficient braking power to provide adequate stopping distances on long sustained grades without the assistance of the motor. One study indicated that at 30 miles per hour, in one of America's finest cars, about 25 per cent of the braking force was supplied by the engine. In free wheeling the heavy car was stopped in 39 feet and in conventional high in 29

feet. Both these represent good stopping because of a particularly powerful brake installed due to the addition of free wheeling.

Whether free wheeling is automatic or selective it would seem reasonable to assume that speeds down hill, at least on the highway, have increased. The manufacturer must design his car to provide as good brakes without the engine as it formerly had with the engine, otherwise it will not be as inherently safe as it was before.

There is still another phase of free wheeling which should be considered and that is the ability to accelerate in an emergency. Modern engines are so quiet that when in free wheeling the normal road noise is sufficient to make it difficult to tell by ear whether or not the engine is running. It is not a sufficient answer to say that this can be determined by watching the instruments or stepping on the accelerator—because motorists will not be bothered to take such precautions. The hazard would come when you "drift" up to a car in free wheeling and attempt to coast by it. If just at this moment, when the overtaking car pulls out of line, an approaching car is discovered, then quick acceleration is needed to pass in safety—if it is impossible to stop. A dead motor at this time represents a definite hazard. There are at least two ways in which this may be provided for. One is a type of free wheeling which automatically puts the car into conventional gear when the engine stops, although this might throw a considerable strain upon the free wheeling system. Another is to arrange the starting mechanism so that as long as the ignition switch is on the engine will automatically be started whenever it stops. Regardless of which method is used provision should certainly be made to automatically keep the engine running whenever free wheeling is used.

It is obvious that the braking system should be completely protected from all failures of other parts, such as the breaking of springs. Many cars have been so designed that a broken spring succeeded in locking the wheel or wheels. The turning of the wheels has sometimes interfered with the linkage system or actually worn through parts of them.

Keeping the wheels on the ground

Next in importance to visibility, steering, and braking is the ability to keep the wheels of a car on the ground. It is impossible to steer or brake unless an adequate contact is maintained with the ground. Let us begin with the point of contact.

Tires—The modern improvements in tire construction have been tremendous. The modern tire is far less susceptible to blow-outs and punctures than were the earlier ones. The toughness of the rubber has increased to the point where many tires will go 40 and 50 thousand miles.

The strong potential mileage of present tires, however, tends to foster one hazard. It is probably true that some 80 per cent of the mileage provides good tread and traction, but the last 20 per cent without tread represents quite a hazard. The safe driver will have the foresight to throw his tires away when the tread is gone, but the majority of our "penny wise and pound foolish" motorists will keep the old tires running until all the rubber is gone. The tire companies should proceed on the assumption previously mentioned, and attempt to allow for human deficiencies by providing tread until the tire can no longer be used.

Blow-outs, while less frequent, and due in part to using tires long after their tread is gone, can still be reduced in number. Their chief immediate cause is probably a result of improper inflation or impact. If safety is to be considered, tires should be designed to prevent blow-outs, regardless of the condition of the tread.

Motorists, generally, are still uncertain regarding the correct inflation to prevent skidding, particularly in wet weather. High pressure keeps less tire surface on the ground for braking, yet low pressure adds to car sway and has probably started many skids. Definite research should be made and the motoring public advised of correct principles. One answer, in view of developments in easier steering, is undoubtedly the use of tires with more surface on the roads.

The new "air-wheels" should receive adequate study and the facts published to develop the individual's faith in them.

Spring and shock absorber action—The next unit between the car and the roadway is the spring and its control, the shock absorber. It is obvious that there are two types of actions which are to be avoided—those which cause wheels to leave the ground, and dangerously interfere with stopping and steering; and those which leave the passenger in the air when the car goes down and catch him in the air when the car comes up. Until recently comparatively little was known about measuring these actions, at least by the average "company operated" service station.

Recently there have been developed devices which measure this action and give the designers, as well as those doing the adjusting afterwards, something definite to work on. By the simple process of raising the car and letting it drop, a complete curve is established for each wheel. The danger point has

apparently been established at a point where the wheel is raised ½ in. from zero. This is compared with the condition where the full body load is upon it (zero position), since common sense tells us that there is not sufficient traction to make a quick stop or turn at higher speeds. Regardless of whether this danger line is absolutely accurate, it does serve as a measuring stick. The testing of many cars has shown not only a great difference between cars but also a considerable difference between the four wheels of a given car. It is obvious that by means of such a measuring stick more comfortable and safer relationships between wheels and roadway can be developed. This simply represents another provision for the use of facts instead of guesswork.

There has been a considerable improvement in the oiling of springs and in the automatic provision for it. It must again be assumed, for the present at least, that the average motorist is too busy to give his car the proper attention. Consequently, those devices which affect his safety at least should be maintained automatically if possible.

Center of gravity and balance—As our speeds increase and corners are taken at greater speeds, it is obviously essential that the center of gravity be lowered, although this should not be done at the expense of other safety features, such as visibility or balance. Some cars today are hard to keep from skidding, while others are quite difficult to skid. The low center of gravity is particularly important where icy or wet patches are found, since sliding sideways onto a dry surface very frequently results in turning the vehicle over. Longer wheel bases, in proportion to the width of the car, are also of assistance in keeping the car from turning over.

Keeping the wheels on the car—Lock nuts, cotter keys, and similar devices are apparently not enough to keep the wheels on the car. It would seem advisable to so design the locking mechanism that unless it is properly in place the last unit cannot be put on. It can hardly be considered wise to leave the decision of whether a wheel will stay on or not to the discretion of the driver or mechanic.

Tread—It would seem advisable to design the tread of a car so that it will not exactly fit the rails of "fixed-wheel" vehicles. Rails are usually the most slippery part of the roadway and have started many skids resulting in accidents. In addition, the rails are sometimes depressed and it is exceedingly difficult to get out of the rut. Several cars have already begun to widen the tread and this trend is apparently in motion.

Distraction of motorist

When street and highway speeds were low, distraction of the motorist was not serious for he did not go very far for every second he took his eyes off the road and he did not cause as much damage when he hit something as he does today. With high speeds, where 50 and 60 miles per hour are frequently encountered, distraction becomes of great importance. A few seconds is enough to move the car a considerable distance straight ahead or to one side or the other. There are enough distractions outside of the car so that any additional ones inside are just a few more than the motorist can stand.

Simple operation of car—It is obvious that the more simple a car is to operate the less attention the motorist will have to give to it and the more attention he can give to keeping his eyes on the road. Free wheeling has undoubtedly reduced the number and energy of movements necessary to shift gears in a car. It is obvious that the more these can be reduced the safer the operation will be. The aim is apparently to cut these down to a simple motion and is in the right direction. For the same reason it is necessary to increase the braking power on free wheel cars so that the same braking distance can be had as before such units were installed—otherwise, the motorist is forced to go through the motions of getting into conventional gear in order to be able to stop as quickly as he could before.

Instruments—Higher speeds have made necessary the improvement of instruments so that they may be read more quickly. If this is not done then the operator will not attempt to read them or will take so long in doing so that he will be involved in an accident before he gets his eyes back on the road. On some cars it takes nearly three seconds for many operators to read the speedometer. In some cases it is hidden by the steering wheel, is over in the center, and is low on the dashboard. At 60 miles per hour a car travels 264 feet during this time. The speedometer is particularly important with modern cars, because the engines are so quiet and the roads so smooth that it is very difficult to tell whether you are going 30 or 40 or 50 miles per hour.

The hand lever for gasoline has sometimes been located so that it is extremely difficult to reach from the driver's seat, particularly when attempting to start on a steep hill.

There are two factors which mainly affect the reading of instruments. These are location and design. Obviously, the nearer the instrument is to

the operator the closer it is in line with his line of vision on the highway, and the more quickly he can read it. This leads us inevitably to the conclusion that all instruments which need to be read or moved while the car is in motion should be located as nearly as possible directly in front of the operator and as high as possible without interfering with his visibility. Thus he will have to take his eyes from the roadway a minimum of time. It is strongly recommended that the speedometer be centered vertically with the steering post and that it might possibly be placed above instead of below the windshield—if that would place it closer, horizontally, to the driver's eyes. Since operators will presumably continue to wear hats, there still remains some space between the top of the windshield and the top of the car, and this space, which is closer, vertically, to the driver's eyes than the dashboard, could advantageously be used for instruments.

The design of instruments is important, and should be such as to provide the quickest and most accurate reading possible. It would appear obvious that the "position reading" arrow or needle type has a distinct advantage. It is hard to read numbers, particularly when they are moving or being shaken by the action of the car. With the position-reading type it is not necessary to read the numbers, since the operator soon learns the position of them and simply notices the relative position or angle of the arrow or needle. It is suggested that in almost all instruments the number of numbers could advantageously be cut down. For example, few motorists are interested in knowing whether they are going 20 or 22 miles per hour. Five or ten mile units would be sufficient and would simplify the reading. It would appear that some study might profitably be made to determine the colors and contrasts to be used for the number and arrow and background, particularly for lighting and night operation. It would seem reasonable that the colors black and white would give the greatest contrast since they are at opposite ends of the spectrum. It would also seem probable that the arrow and the numbers should receive the illumination, and not the background, since that would tend to reduce the area of light which would interfere or compete with the driver's operation.

Some instruments are of greater importance to the motorist's safety than others. It is quite obvious that under high speeds the speedometer is of greatest importance and yet it has not received preferential treatment. For example, in some cars the two largest instruments are the clock and the speedometer—both located equidistant from the center of the car. In some the clock is nearest the motorist, and in others the speedometer is given the better location. It would seem obvious, simple, and economical to add to the safety of the car by always placing the speedometer nearest the driver.

One of the reasons for the past design and location of instruments has undoubtedly been the appearance of the dashboard or instrument panel. However, with the increasing number of instruments and the popular tendency toward "gagetitus" it would appear advantageous to move the vital instruments over in front of the driver and make way for the new and less important ones.

There are many instruments which have only a single point of interest to the motorist, and he is not so much interested in the degree to which the condition is right or wrong. For example, all the motorist wants to know is whether or not his generator is charging, whether or not his car has enough oil pressure, and whether or not his engine is too hot. It would seem rather natural to have the "wrong" condition indicated by a red light entirely automatically. This would reduce the number of instruments to be read by 50 per cent and would be a surer method of calling the motorist's attention to the fact that something is wrong. If this were done it would be possible for the speedometer to be the only instrument continuously illuminated at night, since a separate switch could easily be provided for the gasoline gauge and clock.

It would appear advisable to have some standard adopted for instruments so that their positions, and colors if any, would have standard meanings. This would be particularly true of speedometers, which might be designed so that the bottom is zero and 100, the top 50, the left 25, and the right 75 miles per hour.

Many of the car manufacturers are to be congratulated upon already having adopted some of the simple suggestions such as the above made by the author last January before the Society of Automotive Engineers. The first man to discuss that presentation said, "Gentlemen, we have been presented with a very homely truth." The industry is willing, and is apparently getting under way.

Signalling

Better road surfaces and a lower center of gravity have increased the speed of turning movements so that the "slowing down" of motorists about to make a turn is no longer a satisfactory indication. And since at present motorists do not make their turns from the proper lanes the movement preparatory to turning is no longer a sufficient index. The

general condition has been somewhat aggravated by the increased width of streets and highways and increased intersection speeds.

Hand signalling—Hand signalling is almost a dead science. It would be safe to estimate that probably less than five per cent of the motorists signal before turning or starting. Closed cars, high windows, the general laziness of motorists, and the increasing complexity of driving have been largely responsible for this. The tapering of cars from front to rear has made hand signals less visible. Since it is necessary to put the arm out to the elbow for the signal to be seen, the car design makes this increasingly difficult. If it were not quite evident that hand signalling is "passé" much could be done in car design to make the operation reasonable.

Automatic signalling—For potent reasons of convenience and visibility hand signals should be and will be replaced by automatic signalling. The first step has already been taken in the automatic "stop-light" which works off the foot brake. The general trend is indicated by the increased use of signalling accessories.

Let us consider the location of these signals. To be effective they should be visible from both front and rear. For reasons of visibility they should be located on both sides of the vehicle. This would also provide a simple "location index" of which turn was being signalled. If only one unit is used on each side it would have to be located somewhere near the center of the vehicle. To be seen from this position it would have to project to the outside edge of the running board, at least during its operation. The appearance of a permanent projection would be poor and if this location were to be used the signal would have to be made to project only during its operation. But even with this projection, say, on the forward post, the back of the car would tend to hide the signal, particularly from vehicles following close behind. Thus the location situation seems to resolve itself down to the two rear fenders, and perhaps a single center unit in front, but more likely the two front fenders. This tends to tie in with the tendency of placing lights on the four fenders to show the outline of the car. The first step has already been taken in the use of two rear fender stop lights by many cars. Once electrical units were located at these four points the incorporation of signal units in them would be quite simple.

The design and visibility of the unit is very important. Those who manufacture the semaphore type claim that it is most visible because it changes the outline of the car. Those who manufacture the lens type claim the advantage because they have no moving parts. Both arguments are good, but the type must be chosen in connection with the location used. The semaphore type would not change the outline of the car much unless it was attached to the body. The situation will probably solve itself in the end by the lens type coming to the front, just as it has in traffic control signals at intersections. Both types are at present suffering from a decided lack of visibility. While many of them can be seen at distances up to 100-200 feet they do not have a strong enough attracting power at this range.

There is a definite need to establish a standard for the color and shape of symbols to be used before too many variations get into use. The color red is now generally known as a stop indication. It might appear reasonable to adopt green as the go indication—in the case of arrows, green arrows, following the generally accepted use of green arrows in traffic control signals. The direction of the turn could be adequately indicated by the use of arrows and by the side of the car on which the arrow appeared. If such a standard were to be developed it might be the proper time to bring up the question of tail lights and possibly change the "running lights" to yellow and continue the red as a stop light. At least one manufacturer has attempted to show the speed of the vehicle by having the slow light flash. It is geared to some moving part of the car, and flashes rapidly when the car is going fast. Then the speed of the flash decreases as the car slows up, and stops when the car does.

The control of the signal by the operator should follow the same trend as that of other instruments—it should be as automatic as possible. By the same token that the mechanical signal will replace the hand signal, the function of it should tend to be as automatic as possible. If you cannot get the motorist to stick his hand out the window, it is doubtful whether you can get him to turn such a signal both on and off. It should be designed to turn itself off automatically. This has already been accomplished by at least two manufacturers in two different ways. One is by a time delay mechanism which automatically shuts the signal off after eight or ten seconds. The other is a device attached to the steering mechanism which keeps the signal on until after the turn but automatically shuts it off as soon as the wheels are straightened after the turn. It is not feasible to have the signal for turns automatically turned on by the turning of the steering wheel because the notice of intention should be given considerably in advance of the intersection.

The control switch should be located as near the steering wheel as possible in order to make it read-

ily accessible and to guarantee its use. It has usually been placed at the top of the cowl or dashboard on a line with the right hand edge of the steering wheel.

Signals to indicate a change in direction of motion could probably be built into the car more economically and artistically than they can be added at a later date. Recent word from England indicates that the Ministry of Transport is seriously considering establishing a standard for signalling devices immediately. Certainly the demand exists here, even more, regarding this situation.

Pollution of air

It is necessary that fresh air of the proper temperature and humidity be provided the occupants of cars. Poor air makes driving uncomfortable and tends to dull the senses.

Body construction—The more nearly airtight the body is the more accurately can the problem be dealt with. The most leaky part of the car is usually the front floor boards or the cracks around the doors. The part of the body nearest the engine is most important because it is just at this point that the gases from the engine, as well as those sucked up from other cars, are blown right in to the passengers.

The opening of the windshield not only causes a considerable draught but blows in at considerable speed small stones, bugs, and bees, all of which are apt to interfere with driving, particularly with the use of the eyes.

The development of ventilation is still not very far advanced. During cold weather, it should not necessarily be assumed that all the ventilation must be through the windows. If the air is taken in from the front it causes strong draughts. Why would it not be possible to follow the experiments of "Pullman" where they came to the conclusion that the air should be sucked out of the body and be permitted to leak in through the numerous small gaps? They left the windows almost entirely out of the problem.

The heating of a car has been considerably improved, yet many of the systems bring motor gas and smell into the car—a good part of it probably being due to leakage in the flexible tubing.

Carburetion—The real source of gas and smell is probably the halitosis of the engine due to the improper diet which it is given by the carburetor. This faulty carburetor adjustment is particularly true of buses, which usually exhaust such an odor that motorists hate to drive behind them, and frequently take considerable risks to pass them. Some time ago progress was reported on a device that would adjust the carburetor from the condition of the exhaust gas. If the problem were attacked from this end, economy and fresh air might be achieved at the same time.

Muffler—Leaky mufflers are another source of air pollution. If the "straight through" type expands in its use this difficulty will probably be greatly reduced. A further improvement might be to move the muffler toward the rear of the car, or to provide a draught or ventilation toward the rear for it. It might be possible to use the blast from the exhaust to suck the air out of the car body unless such a process would tend to develop back pressure. Some combination with the fan and draught through the radiator might also be utilized.

Comfort

Comfort has a part in preventing accidents. Its relation to fatigue is probably the most important item. Each year longer trips are customarily taken by motorists and many accidents are undoubtedly caused by a tiring of human faculties and a slowing down of their reaction time.

Ability to stretch—Many cars do not have sufficient room for the driver to change his driving position. This inability to stretch gives a feeling of being cramped and tends to make the motorist nervous and irritable. The adjustment of the front seat has improved the situation somewhat, but not altogether because for each driver the front seat has one position which places him in the best position to reach the steering wheel and other control levers. If in this position he does not have sufficient room for his feet, he is not comfortable.

Arm rests—Since windows seem to be getting higher, particularly in relation to the driver's seat it is becoming increasingly difficult to rest the left arm. This would tend to show a demand for an arm rest.

Steering wheel—Front seats are being made wider to accommodate the usual "three in front." This means that with the steering wheel centered in the middle of the left half of the front compartment, the driver does not sit directly behind the wheel. Even with only two in the front seat the driver is tempted to sit clear to the left in order to find an arm rest. In addition to not being directly behind the wheel he is more nearly behind the left windshield pillar and his visibility is lessened. It would seem advisable to locate the steering wheel directly in front of where the driver will sit if there are three in the

front seat and to make the windshield just as wide as the front seat. The angle of the steering wheel to the operator might also be advantageously studied from the viewpoint of safety and comfort.

Foot pedals—Many of the foot pedals are not located at the proper angle and the driver's foot soon becomes cramped. In some cars the accelerator is too far to the right, particularly when three are in the front seat. The whole instrument assembly can be vastly improved from the viewpoint of comfort to the operator. Low brake pedals, made more possible by power brakes, will be quite an improvement and will cut down the time necessary to put on the brake.

With the advent of free wheeling and power brakes we are likely to have a complete revision of the location of the clutch, brake, and accelerator levers. Before this comes it would be highly advisable to have a comprehensive study made and a standard location determined upon.

Fire hazard

While the fire hazard of the automobile has been greatly reduced, there are still too many cases of motorists being burned to death. Most of these are probably due to crashes.

Gasoline tank—The design and location of the gasoline tank is undoubtedly important. Its location in front is rather doubtful due to its proximity to the carburetor and its pipe lines and to the ignition. Its location in the extreme rear may have some drawbacks because of rear-end collisions and the danger of its being punctured by sharp objects which may cause explosions due to sparks. It should probably be located in such a position as to be protected by the body and the frame.

Pipe lines—Pipe lines are probably the greatest fire hazard. They are more subject to breakage than the gasoline tank and many of them are closer to the hot parts of the motor and the ignition system. It would seem advisable to give them the physical protection of the frame and the motor wherever possible instead of merely running them across large air gaps. It is obvious that special precautions must be taken when lines are carried from one part of the car to another which may give slightly under road shock. The expansion of the carburetor, its cleaner, and silencer, etc., may be of assistance in providing adequate mounting. The entire layout should be based upon the assumption that sometime during the car's life it will be involved in a serious crash.

Ignition—Ignition systems have undoubtedly improved tremendously and short circuits are far less frequent. There probably, however, remains much that can be done to design them so that failures will not result in sparks and fires, or explosions. The layout should avoid as much as possible the gasoline tank, the pipe lines, the carburetor, or any surface where gasoline leakage or a crash might provide the combination necessary for an explosion.

Reducing damage after accident

With the large number of accidents occurring each year, the car manufacturer should expect each vehicle to be involved in at least one accident and should design his vehicle to stand it. With collisions occurring at high speeds, the impact is terrific. If tables showing the kinetic energy developed at different speeds for a 3000 lb car were consulted, it would be noticed that the foot-pounds developed at 30 miles per hour are only little more than half of those developed at 40 miles per hour and that the braking distance is almost in the same proportion. Thus the higher speeds permitted by "improved" cars have placed a considerable premium upon the strength of the car when an accident occurs.

Non-shatterable glass—Figures obtained from interviewing car owners indicate that in all accidents involving personal injury, 45 per cent were injured by broken glass. A more recent study in Baltimore showed that 36 per cent of the persons injured in traffic accidents were cut by glass. It is perfectly obvious that the greater part of this damage can be reduced by using non-shatterable glass. This type of glass has been "made available" throughout in some of the higher priced cars, is stock equipment in the windshields of others, and can be provided in most cars at an "extra" charge. Recently one manufacturer has come forward with this feature in all windows of his cars in their four price classes —a definite step toward safety. The Michigan law will require it in all "public conveyances" in 1933 and in all vehicles by 1934. Since the trend and the law will require it, the problem resolves itself down to developing a product which will not discolor and which will resist breaking. With speeds still increasing, it is obvious that even more glass will be broken and that non-shatterable glass will be even more important.

Strength of body—The strength of the body should be such as to offer the passengers some degree of protection—it should not merely serve as a unit to hold the top up and hold the windows in

place. Its greatest weaknesses are probably the doors and the top. The doors could probably be designed so that when hit they could draw from the vertical and top members for support.

The top is probably the most vulnerable part of the body. In many cases it simply will not stand up under the strain of having the car turned over. While the vertical supports may be of sufficient strength, the joints are not of equal strength, particularly when it comes to a twisting action. It is obvious that there is little value in having some points strong and others weak, since the top will give at the weakest link or point. The whole body should be of equal comparative strength and any one part should receive support from every other part.

Sharp projections—The deceleration of the modern car is greater than will permit the passengers to keep their seats in an emergency and certainly the impact of an accident is sufficient to throw them with considerable force. A passenger weighing one hundred and fifty pounds if traveling in a car going at 60 miles per hour will develop 580,800 foot pounds of kinetic energy. If this body is stopped suddenly, something very unpleasant will result even if the body of the car does not crush and it resists the shock. The inside of the body should thus be as free from sharp projections as possible. The instrument panel and cowl layout can be made less irregular. Hard rubber steering wheels probably prevent the rim from breaking and puncturing the driver. The cross bars in the roof might be so located as to prevent passengers from hitting them when thrown by bumps or collisions. Provision should be made to prevent the hood rod from being pushed into the driver's seat and through some passenger. In airplane design I understand it is quite common for "crash-pads" to be built in, although the accidents per unit of operation are supposed to be less than those of passenger cars and trucks.

The safety catch on doors has without doubt cut down the number of injuries due to doors opening and letting passengers out "en route" although there are still cases of it due to the body of the car being twisted or struck suddenly. Some doors are also designed so that in case of any accident where the body is struck they cannot be opened, and the passengers are kept inside the car to drown or burn.

It is believed that considerable property damage could be reduced by establishing a standard height for bumpers, and by providing side bumpers or designing the running boards to serve the purpose of side bumpers.

Acceleration—Speed

While the ability to "pick-up" quickly has permitted some operators to avoid accidents, it has tempted other operators to take unnecessary chances.

Since speed has continued to go up, the question now arises as to what is the limit. It is obvious that neither the car, nor its price, nor the roadway are the limits. While present roadways are not safe for the present speeds at which they are used, it is conceivable that main highway surfaces, curves, and intersections can be built which will safely take much higher speeds. The limit is undoubtedly the individual. Eventually a maximum speed will be determined beyond which the average motorist cannot drive safely. The restrictions will be such things as "reaction time", "preservations", the fluctuation (chronologically) of the individual's ability, and his judgment in emergencies.

If we consider the element of reaction time alone we can see the effect of increased speed. The reaction time of the individual motorist is approximately one second. In driving a car this means that it is one second from the time the motorist decides to stop until the brakes are actually in operation. At 30 miles per hour the car travels 44 feet per second, while at 60 miles per hour it travels 88 feet per second. Thus at the former speed the motorist goes 44 plus 90 or 134 feet before he stops, but at the latter speed he goes 88 plus 360 or 448 feet before he stops, or over three times as far. It is doubtful if the "average" motorist is capable of operating a vehicle much beyond the point where his potential collison area is 448 feet ahead of him. From the manufacturers' viewpoint, however, the difficulty is that the car's maximum speed must be high so that a fairly high cruising speed may be obtained without putting a considerable strain on the motor —and, further, there are some drivers and some roadways which can utilize the higher speeds with safety. This may lead us into some sort of control or automatic restriction.

Speed governors—Governors to control the speed of vehicles have been used for some time on commercial vehicles. As the speeds go up, this will become increasingly important. The heavy commercial units at present are not able to stop as quickly as the passenger cars. This simply means that they are not as safe at high speeds. Further, they are capable of doing considerably more damage in case of an accident.

It is quite possible that speed control will eventually have to be placed upon cars driven by the reckless and the incompetent. This would naturally remove from the manufacturer any restriction on speed

and he could go ahead and build cars with higher maximum speeds until his highest economical cruising speed reached the limit set for average safe operation.

Governors should be so designed that they do not interfere with acceleration, so that they retain their accuracy, and so that they may be effectively sealed and protected against tampering.

Maintenance of vehicles

Many of the features of the automobile may be entirely safe when it leaves the factory, but unless they receive adequate maintenance they may soon become very dangerous. The motor vehicle equipment inspection campaigns carried on by many of the states are merely a protective measure. They are designed to force the motorist to keep his vehicle in as safe a condition as it was when it left the factory. The automotive industry should be just as interested in seeing this done as they are in building safe vehicles. In addition, these inspections mean profit to them through repairs, parts, and the removal of used cars which are unfit to drive—no small aid to the "used car problem."

The operation of inspections has recently been improved in its accuracy and in its convenience to the motorist. This has been accomplished largely through the establishment of permanent stations which are regularly inspected by the motor vehicle commissioners. The number of stations has also increased so that the motorist does not have to drive long distances to have his vehicle inspected.

The entire automobile industry should get behind this movement which is of definite assistance to safety and a business aid to themselves.

It would be helpful from the safety, as well as the business viewpoint, if the industry would keep in continuous touch with its customer. The sale should begin and not end the relationship. In this way the owner would keep his car in better shape and would have less accidents due to poor maintenance.

How the industry can further assist safety

In addition to building safety into their vehicles, there are many other ways in which those in the industry can promote safety.

Car manuals—All car companies present their customers with a little manual telling how to maintain the vehicle. It would be helpful if all those items having to do with safety could be placed under one heading so that the motorist can easily find them.

Safety and maintenance posters—Small posters could be placed on the windshield and large ones on the windows of showrooms which could tie together safety and maintenance, thus serving two purposes, both valuable to the industry.

Advertising—Safety is a term very much in the public eye today and can advantageously be tied into advertising. During the last year there have been many excellent examples of this, such as non-shatterable glass, strength of tops, better brakes, etc.

Conclusion

The number and severity of accidents are still on the increase due largely to driving speeds higher than the existing roadways and drivers can handle with safety. This condition will undoubtedly continue until the advance of the various factors involved has been adjusted, and until the organization, personnel, and public attitude has been developed sufficiently to offset it. Since it is understood that on the first of the year at least three cars will be offered which will cost less than any now manufactured and which will out-perform present cars, the safety problem is apt to become even more acute.

Safety demand must be met—Safety is very much in the public eye today. The motorists have been informed of the seriousness of the condition. Thousands of safety meetings are held each year. Still more thousands of people are actively engaged in safety work. The amount of printed safety material, addresses, and radio talks will without doubt increase next year so that the theory and practice of safety will be even better known.

It is apparent that the industry must meet this demand for sales purposes, just as it improved the appearance of the car when women drivers became a factor, and just as it built faster cars when the demand for greater mobility became evident.

It is equally evident that the building of safe automobiles and the active participation of the industry in safety campaigns is a business aid and that much good will and profit can be made in this way.

Industry knows the answers—In the majority of the safety problems, as they affect the construction of the vehicle, the industry already knows the answer. Take the example of brakes. It is the opinion of quite a few automotive engineers, who are in a position to know what they are talking about, that there are probably not more than three stock cars manufactured today which have brakes adequate to stop them at 60 miles per hour. By this

I mean that three emergency stops at that speed would rob the braking system of its effectiveness. And yet there is not a private car manufactured today that will not do 60 or 70 miles per hour and that is not quite frequently used at that speed. Common sense should dictate that if you make a car which can go 60 then you should provide brakes that will stop it at 60, not three times, but often enough so that continual frequent maintenance, which the motorist will not give it, is not necessary.

Depression and improvements—There can be no doubt that in periods of depression the motorist gets more improvements and more car for his money than he does during times when "cars are selling" and there is no urgent need to improve them beyond that stage which normal competition requires. Business is business, and there is no reason why the inventions should be handed down from shelves, except those which affect safety. "Good business policy" during the next few years will probably make it necessary for the manufacturer to pull out his aces and play them. The demand for safety is here and is growing rapidly. It is hoped that the effort to manufacture a product at a lower figure will not sacrifice safety. In the long run that would represent poor economy.

Demand for better records—It is difficult to make improvements based on the facts regarding past experience. There is a definite demand for more and better facts regarding automobile accidents. The fault does not necessarily lie with the administrators, who too frequently do not have the personnel nor the money to investigate each and every accident. Yet, somehow, complete records will have to be kept before great progress can be made. The redeeming feature is that there has been improvement along this line and the changing public attitude will make possible the mechanisms necessary to accomplish it.

Combined technical committee of industry and motor vehicle commissioners recommended—There is a far-reaching fundamental demand for a combined committee of those who make the vehicle and those who administer the regulations governing its operation. Their problems are mutual and thorough cooperation is needed to insure good business and safety. Unless each is aware of what the other is doing, considerable hardship will result.

It does not appear reasonable that the industry should be forced by law into building certain things into their vehicles, particularly when they are entirely unprepared for it. The motor vehicle administrators are under considerable public pressure and laws are frequently passed over their heads. Now, if a committee were in operation, the administrators could advise the industry of demands as shown by their records and the car manufacturers could be prepared for them. On the other hand, the industry may be planning some new improvement which if "sprung" on the administrators might be defeated. The results to the manufacturer if "free wheeling" had been blocked are quite obvious, and it was quite possible that it might have been under many of the anti-coasting laws.

There is an old saying that "unless you are up on a thing you are down on it" which augurs well for such a committee. A full and complete understanding of each others' problems would make far less possible misunderstanding and ill feeling.

Last January, the author in addressing the Society of Automotive Engineers before their annual meeting on the "Relationship between Automobile Construction and Accidents" suggested a committee of 12, six from industry and six from the administrators, the personnel to be composed of strictly technical men. This would necessarily require that each administrator maintain a man thoroughly familiar with automobile construction. The functions of the committee would be entirely non-political. It should probably meet once a month in order to keep up to date on all developments. It was hoped that such a committee would be set up within the next six months in order that its benefits would begin to make themselves felt on the accident problem. Since then, a committee with similar functions has been set up and has had at least one meeting.

What has been done so far

Comparatively little has actually been accomplished regarding the actual establishment of safety standards for the automobile. A comprehensive headlight study was made about 1927 but something, perhaps dissatisfaction in its findings or its general status, prevented it from making a definite improvement in the situation. A brake standard study was begun in 1923 under ASA procedure, but its operation was so slow that when its findings came out on two-wheel brakes almost all the cars being manufactured had four-wheel brakes. Steps are now being taken to rejuvenate these two studies.

The Society of Automotive Engineers have established a standard for reflecting devices on cars, but this has not yet been adopted by all the motor vehicle administrators.

Many of the improvements suggested in this paper have already been put into effect by some car manufacturers. At least one company reports a good return from selling its product largely on the basis of safety.

What is now being done

The National Bureau of Casualty and Surety Underwriters is promoting a standard for non-shatterable glass and is being advocated as sponsor under ASA procedure.

There have been 20 motor vehicle equipment inspection campaigns and seven states have passed laws requiring them. These require that the safety features of an automobile be kept up to a certain standard.

"Consumers' Research" has advised car buyers as to the status of certain vehicles regarding certain factors. It is hoped that they will find it possible to expand their activities, particularly regarding safety factors.

The National Bureau is about to start a study of "air-wheels" to determine their relative safety and to set certain functional standards for their performance.

Suggested safety standard

It is recommended that safety standards for automobile construction and maintenance be established under ASA procedure. These should be functional in character and should represent minimum requirements. They should cover all of the more important items discussed in this paper. The work should be done at once so that the standards can be issued before they are out of date. The American Standards Association appears to be the right body to handle this work. It is not unreasonable to suppose that the National Bureau of Casualty and Surety Underwriters might eventually use such a standard for the purpose of approving cars and possibly making some rate differential upon this basis. Such processes have been used by the Underwriters' Laboratories, National Bureau of Standards, *Good Housekeeping*, etc.

If the number and severity of accidents increase much more, a definite reaction may set in. This would place unexpected burdens on both the industry and the motor vehicle administrators. Legal requirements that all cars be able to stop at their maximum speed under full load in so many feet a given number of times without adjustment or repairs would be most embarrassing at present. It would appear much more intelligent and far less painful to set up safety standards. As long as these are kept functional and represent minimum requirements there is everything to gain and nothing to lose.

A "boom" in accidents during a period of "depression" is not pleasant but it must be met. Safety standards represent one obvious method.

Safety Requirements for Small Electrical Equipment

A new and revised edition of *Fundamental Safety Requirements for Electrical Equipment to be Used by the Public* has been published by Electrical Testing Laboratories in its capacity as Technical Agent of the Appliance Committee of the Association of Edison Illuminating Companies. These requirements have been under development for nearly three years, having grown out of a need for a reference standard in regard to safety for use in the determination of relative qualities of domestic electrical appliances. The document appears to be unique in that it comprises the results of a study of the elements of safety and attempts to classify its various aspects in these applications. The following sources of hazards are specifically considered:

I. *Electrical*—Close approach to, or personal contact with, surfaces carrying voltage capable of producing harmful physiological effects;

II. *Thermal*—The production of electric arcs or harmful temperatures in parts or materials with which persons may come into contact or which may come into dangerous proximity with combustible or explosive materials (except as may be required for the normal functioning of heating appliances);

III. *Mechanical*—Unnecessary exposure of moving parts capable of causing personal injury, construction so unsubstantial or the use of materials so impermanent as to contribute to hazard; design or location contributing to personal hazards of other kinds;

IV. *Chemical*—Noxious fumes or gases, drippings or spatterings of material capable of causing injury or damage; chemical reactions capable of contributing to hazards of other kinds;

V. *Radiational*—Uncontrolled deleterious radiation of such intensity as to make personal injury possible under conditions likely to be encountered in service;

VI. *Functional*—Misuse; in protective equipment, abnormal conditions in other equipment against which the device under consideration is intended to provide protection. (For application to such devices as fuses, circuit breakers, switches in so far as they constitute protective equipment, and automatic controls such as are employed in gas and oil burners.)

Specific requirements are detailed under each of these headings. One of the more important of these is that for adequate electrical insulation. Two tests

are stipulated for this purpose. The first is a measurement of leakage current flowing through insulation with working voltage applied. It is required that this leakage current must not exceed 0.2 milliampere, which is the value that tests conducted by the Electrical Testing Laboratories showed to be close to the threshold of physiological perception. The second test is a proof voltage test with 1000 volts, 60 cycles, applied for a period of one minute. Each of these tests is performed with the device in various stated conditions as regard temperature and humidity.

These Fundamental Safety Requirements have been widely distributed among those most competent to advise in regard to their development, and have benefited from the attention and suggestions of engineers in electric utility organizations, inspectors, state and municipal regulatory officials, and a few others professionally interested in safety in general. They now constitute the safety requirements of the Appliance Committee of the Association of Edison Illuminating Companies, for application to domestic electrical appliances.

Copies may be had upon application to Electrical Testing Laboratories, Eightieth Street and East End Avenue, New York.

State Requirements for Industrial Lighting

In spite of the fact that 13 states have promulgated industrial lighting codes and that great emphasis has been placed upon good lighting as an accident prevention factor, a large number of plants are still ignorant of the value of good lighting. This point is brought out by the investigation made in about 1,300 industrial establishments as reported in a Bulletin published by the United States Women's Bureau entitled *State Requirements for Industrial Lighting*.[1]

This new contribution to the campaign for better lighting conditions in the industries of the country is intended as a handbook for the protection of women workers, but it is of great value to everyone because of the fundamental material which it contains. It can serve as a guide in the installation, maintenance, and use of lighting systems.

The Bulletin contains a partial reprint of the American Standard Safety Code for Lighting: Factories, Mills, and Other Work Places, and discusses several of the more important sections of the code, such as natural lighting, measurement of illumination, maintaining the level of illumination, avoidance of glare, and the use of the foot-candle meter. In addition, a chart showing the status of state lighting codes is given. This is valuable in helping the reader to know what the legal requirements are in the locality in which he is operating a plant or in which he is working.

In all, the Bulletin is intensely practical and filled with facts relating to this immensely important phase of accident prevention work. It should certainly be in the library of everyone interested in the subject.

CYRIL AINSWORTH

[1] Bulletin No. 94, Women's Bureau, U. S. Department of Labor.

Standardization of Metric Magnetic Units

For more than 30 years there has been some ambiguity and difference of usage among magneticians in all countries as to the meaning and application of the unit name *gauss*. Some writers have used the *gauss* for the unit of magnetizing force H, others for the unit of magnetic flux density B, and some for both these quantities indiscriminately. The confusion has been a hindrance to readers, writers, students, and teachers everywhere. Standardization was, therefore, very desirable for the sake of simplicity and of international uniformity.

On July 9, 1932, the Symbols, Units, and Nomenclature Committee of the International Union of Pure and Applied Physics, under the chairmanship of Sir Richard Glazebrook, held an international conference at Paris to discuss the standardization of C.G.S. magnetic units. The minutes of that conference have recently been issued. Either unanimously, or by considerable majorities, the conference voted:

1. Not to modify or "rationalize" the classical C.G.S. system.
2. To accept the convention that B and H are physically distinct quantities; so that their ratio μ, the permeability, is also a dimensional physical quantity, and not a mere number.
3. That the following unit names are acceptable in the C.G.S. magnetic series:
   (*a*). For magnetic flux Φ, the *maxwell*
   (*b*). For flux density B, the *gauss*
   (*c*). For magnetomotive force F, the *gilbert* or *oersted-cm*.
   (*d*). For magnetizing force or field strength H, the *oersted*.

The above recommendations are in agreement with those adopted by the International Electrotechnical

Commission[1] at its plenary meeting in Oslo, July, 1930, on the recommendation of its Advisory Committee 1 on Nomenclature which met in Stockholm in 1930. The 1930 recommendations of the IEC were endorsed at London in 1931.

If, therefore, the above IEC—I.P.U. conventions are adopted by magneticians, the former ambiguity should disappear from magnetic literature.

A. E. KENNELLY, *Honorary Secretary,*
United States National Committee,
International Electrotechincal Commission.

Foreign Standards Available from ASA

New foreign standards available to Sustaining-Members for loan or purchase through the ASA office are listed below. They are available in the language of the country under which they are listed. In requesting copies of the standards it is necessary to list only the ASA serial numbers preceding the titles. Send either a post-card or a note containing only the name and address of the person wishing to receive the standards, and the numbers of the standards desired. The card or envelope should be addressed to the American Standards Association, 29 West 39th Street, New York.

Serial Number

Great Britain

250. Use of structural steel in buildings
251. Xyloles (pure xylole, 3 deg. xylole, and 5 deg. xylole)

Belgium

252. Specifications for switches, outlets, and circuit breakers with enclosed fuses
253. Standards for regular incandescent lamps with metallic filament

Canada

254. Standard blade punching for road grading machinery

Germany

255. Adding machine details
256. Briquetting moulds, length, and thickness, mining
257. Briquetting moulds, width and profiles, mining
258. Briquetting moulds, width and profiles, mining
259. Briquetting plungers, mining
260. Compressed air hoists: introduction, specifications for requisitions and acceptances, data for investigation and requisitioning, summary and working tables, standard dimensions for class three (250/300), class four (300/400), and class five (350/500); mining
261. Compressed air transmission; loose pipe flange with collar, for pressure-type 10, working pressures W10, G8, mining
262. Compressed air transmission, pipe fittings T, 90 deg. elbow, reducer, coupling flange, mining
263. Compressed air transmission; valves: header, return and gate, mining
264. Dump car, hingepin and dumping hook, mining
265. Identification colors for pipe lines
266. Light hoisting cage, safety hingepin and side bar, mining
267. Light hoisting cage, single deck, for ore car, drawings, mining
268. Light hoisting cage, single deck, for ore car, list of materials, mining
269. Manhole cover for sidewalks, frames
270. Manhole covers for highways, circular frame with plain foot, nominal size 510
271. Manhole frames and covers for highways, cover to be filled with asphalt, nominal size 500, 600, and 700
272. Manhole covers for highways, cover to be filled with wood, nominal size 510
273. Manhole frames and covers for highways, cover to be filled with wood, nominal size 500 and 600

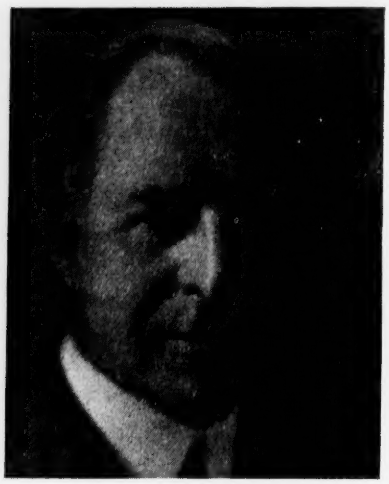
Federal Specifications Available

The following Federal Specifications relating to foodstuffs have been published recently and may be purchased at five cents per copy from the Government Printing Office, Washington, D. C., or may be purchased or borrowed through the office of the American Standards Association: evaporated (or dried) apricots; smoked bacon; canned corned beef; canned sliced dried beef; fresh beef; dried currants; concentrated feedstuffs; grains; sweet-pickle cured smoked hams; canned corned-beef hash; feeding hay; beef hearts; beef kidneys; lard substitutes (including vegetable shortening); liver; mutton; noodles; evaporated (or dried) prunes; canned squash; canned beef tongue.

[1] See "Actions of Electrotechnical Commission on Names for Metric Magnetic Units" by A. E. Kennelly, ASA BULLETIN, June, 1932, p. 183.

Lyman J. Briggs a Director of ASA

Dr. Lyman J. Briggs, Acting Director of the National Bureau of Standards, has been elected to membership on the Board of Directors of the American Standards Association representing the U.S. Department of Commerce.



Lyman J. Briggs

In addition to his duties as Acting Director of the National Bureau of Standards, Dr. Briggs is Acting Chairman of the Federal Specifications Board and of the National Screw Thread Commission.

Dr. Briggs' entire life since college days has been spent in the service of the Government. He joined the staff of the Department of Agriculture in 1895, and was in charge of the physical laboratory of the Bureau of Soils until 1906. From 1907 to 1917 he was in charge of the biophysical laboratory of the Bureau of Plant Industry. The method which he developed for classifying soils on the basis of the amount of water the soil can retain in opposition to a given centrifugal force is now used the world over.

At the beginning of the war in 1917 Dr. Briggs was detailed by executive order to the Bureau of Standards and was assigned to problems in the field of aerodynamics and ballistics. During this period he developed, with J. F. Hayford, a gyroscopic instrument for maintaining an artificial horizon below deck as an aid in directing gun-fire from battleships. These instruments are now installed on many of the battleships of the Navy.

In 1920 Dr. Briggs was made Chief of the Division of Mechanics and Sound of the Bureau of Standards, and in 1921 he received, in collaboration with P. R. Heyl, the Magellan Medal for a new earth-inductor compass for use in aircraft. He also made a special study of the characteristics of airfoils held in air-streams moving at speeds as great as the speed of sound, which gave information applying directly to the design of aircraft propellers. In 1926 he was appointed Assistant Director of the National Bureau of Standards, and has been Acting Director since the death of Director George K. Burgess on July 2, 1932.

Value of Welding Standards

The American Welding Society has come to recognize the value of specifications and standards. For example, in the early days a wide variety of nomenclature and definitions was in vogue. Welding experts did not talk the same language. To meet this need a committee was appointed to draw up standard nomenclature, definitions, and symbols. Not only has the matter of the common language been successfully solved, but standard symbols enable the draftsman to specify clearly and concisely the type, location, and size of welding to be used, thereby eliminating confusion and expense. Other standards developed by committees of the Society or its research department known as the American Bureau of Welding include standard tests for welds, standards for arc welding apparatus, specifications for welding wire, and gages for measuring dimensions of welds.

Perhaps the growth of welding during the past few years has been, to a large extent, due to the maintenance of quality standards and procedure specifications. In this way it is possible to eliminate the doubt as to the quality of workmanship, and engineers have, in general, come to look upon welding with greater confidence.—*Editorial reprinted from "Journal of the American Welding Society," August, 1932.*

Simplified Practice Recommendation on Pipe, Valves, and Fittings

The revised Simplified Practice Recommendation on wrought iron and wrought steel pipe, valves, and fittings became effective on October 1, according to a report by the Division of Simplified Practice of the National Bureau of Standards. The recommendation as revised omits the "double extra-strong pipe"—the 3½ in. nominal inside diameter pipe. It applies only to new installations of pipe and to the production of pipe.

Definition of the Inch[1]

by

H. W. Bearce[2]

The development of mass-production methods and close control of dimensions to insure interchangeability of parts has made it necessary for industry to measure the dimensions of many products with a degree of accuracy which would, until recently, have been considered quite impracticable. The need for accuracy in measurements obviously carries with it the need of correspondingly precise definition of the units in which the results are stated. Consequently, discrepancies between units which would have been of merely academic interest a few years ago are now of immediate and practical importance to industry. This fact has given new importance to the old question of the relation between the yard and inch of Great Britain and the corresponding units used in the United States, as well as the relation of these units to the meter and millimeter.

For nearly all industrial and commercial purposes the United States inch and the British inch may be regarded as equal, although they are now derived from different sources, and although their basic definitions differ. It is only when we are concerned with length measurements of high precision, such as the measurement or comparison of precision end-standards or line-standards, that any difficulty whatever is encountered through lack of exact agreement.

Manufacturers of precision limit gages are regularly working to an accuracy of a few hundred-thousandths of an inch, while manufacturers of precision gage blocks are attaining an accuracy of one or two millionths of an inch per inch of length. Obviously, in work of this character, uncertainty or indefiniteness to the extent of the difference between the United States inch and the British inch (about 1 part in 363,000) cannot be tolerated.

Furthermore, certain precision measurements in industry and in science are made in terms of the inch, others in terms of the millimeter, still others in terms of standard wave lengths of light. It is highly important that measurements made in terms of one unit be readily and precisely convertible to either of the other units.

[1] Reprinted from *Mechanical Engineering*, October, 1932.

[2] Co-chief, Division of Weights and Measures, United States Bureau of Standards, Washington, D. C.; secretary, National Screw Thread Commission; secretary, American Gage Design Committee; member, Sectional Committee on Allowances and Tolerances for Cylindrical Parts and Limit Gages (B4).

Several years ago this problem was discussed by the present author[3] and a solution which seemed practicable was proposed. Since that time considerable progress has been made toward the acceptance of a consistent system of length measurements throughout the world. While there are still differences of opinion with regard to the proper theoretical basis for such measurements, some recent developments indicate that on all points which are important for practical purposes a general agreement could easily be reached. The purpose of the present paper is to point out the possibility of reaching such an agreement without requiring any great changes in previous conceptions.

Recent proposals for defining the inch

A special committee organized under the procedure of the American Standards Association has now pending before it a proposal to adopt as an American Standard for industrial use the factor 25.4 for converting inches to millimeters. This committee has recommended that a conference of interested organizations be called to consider the proposal.

The suggestion of using the simple ratio mentioned is, of course, not new. Its adoption was definitely recommended in 1926 by a conference of representatives of the standardizing bodies of 18 countries, including the American Standards Association and the British Engineering Standards Association. It is, in fact, already widely used both in making computations and in designing mechanical devices for cutting screw threads, ruling scales, and carrying out other operations where conversion between inches and millimeters is involved. The mechanical advantages of this simple ratio were discussed in Bureau of Standards Scientific Paper 535[3] where it was also stated that official acceptance of this relation would serve to harmonize the theoretical relation with necessary mechanical practice. Adopting a ratio between units does not, however, fix their values until one of the two has been independently defined.

Another proposal recently published suggests the possibility that all concerned with precise length measurements in this country might agree upon a

[3] H. W. Bearce, "A Fundamental Basis for Measurements of Length," B. S. Sci. Papers, vol. 21, p. 395, 1926-7 (S 535).

basic definition which would have a very good chance of general acceptance throughout the world. The late Luther D. Burlingame, in a paper presented to the American Institute of Weights and Measures in December, 1931, coupled with the acceptance of the conversion factor 25.4 the further proposal that the yard be defined as 1,420,212 wave lengths of red cadmium light. This would make the inch equal to 39,450⅓ such wave lengths. The principle involved in this proposal is entirely in accord with the most modern scientific thought. With a very slight change in the specific number of wave lengths proposed by Mr. Burlingame the complete proposal would be acceptable to scientific circles. It would then give a basis for a restatement of the legal definition of the yard (and inch) which would remove all discrepancies between legal, scientific, and industrial values for the United States inch. It would also go more than half-way toward reconciling the present difference between the legal values of the inch as prescribed in the United States and in Great Britain.

The step necessary to obtain this fortunate result would be to define the yard as 0.9144 meter, which is equivalent to 1,420,213.28 wave lengths of red cadmium light. This would make the inch 39,450.369 wave lengths, instead of 39,450.333 as proposed by Mr. Burlingame.

It will be evident that for industrial purposes the difference of 0.036 wave length of light to the inch is not very serious. On the other hand a difference of this magnitude is not negligible for spectroscopic work and other optical and interference measurements. The value of the meter expressed in light waves has been established to such a precision that a change in it in this proportion cannot be considered. The International Astronomical Union has for 25 years used the value 1 meter equals 1,553,164.13 red cadmium wave lengths. This value is believed to be accurate to one part in ten million. Furthermore, this value was at least provisionally recognized by the Seventh General Conference on Weights and Measures in 1927 as a secondary definition of the meter. This definition has already found wide use in the manufacture and testing of precision gage blocks, and in the ruling of line standards of high precision. The suggested modification of Mr. Burlingame's proposal is therefore necessary in order to make the ratio 25.4 to 1 represent the precise relation between the revised value for the inch and the universally accepted value for the millimeter.

The proposed conversion factor (25.4) is not precisely in accord with the present legal basis for the inch in this country. The Act of 1866 provides that the meter shall be considered as the equivalent of 39.37 inches. It is doubtful whether this was intended to establish a precise value beyond the number of figures given, but if one so interprets it, the number of millimeters to the inch is 25.40005 (approximately). Since 1893 the actual United States yard and inch have been based upon the International Meter through the use of these conversion factors established by the law of 1866. The national standard is Meter No. 27; it has twice been recompared with the international standards, and the relative lengths have been found to remain constant within the limits of error of the most precise comparisons. The units of length derived in this way have undoubtedly been maintained with a higher degree of accuracy and constancy than would have been possible by the use of any other standard available.

Since the Bureau of Standards assumed responsibility for the maintenance and promulgation of units in 1901, it has been considered best to adhere to the basis which had been established by the Weights and Measures Office of the Coast and Geodetic Survey in 1893. The inch as used by the Bureau is therefore not 25.4 millimeters, but 25.40005. In other words, the present United States inch is larger by 2 parts in a million than the value which it is proposed to adopt as an American industrial standard. It is equal to 39,450.448 wave lengths of the red radiation from cadmium instead of 39,450.369. Gage blocks are calibrated on this basis; line standards are graduated and calibrated on the same basis. Any change from that basis will mean a change in the United States inch. Nevertheless this change is advocated in the belief that it would be advantageous for industrial purposes, while also holding out the hope of ultimate agreement with Great Britain so that the "inch" would have an unambiguous value. The simplest legal basis for the precise values desired would be to define the yard as equal to 0.9144 meter, exactly, instead of specifying 39.37 inches as the equivalent of the meter.

Relation of the United States inch to British inch

Since 1855 the British yard has been defined as the length, at 62 F, of a certain bronze bar made in 1845, and the inch as 1/36 of the yard as so defined.

Since 1898 the relation between the British yard and the International Meter has been officially expressed by the following equation:

$$\frac{1 \text{ British yard}}{1 \text{ meter}} = \frac{3600}{3937.0113}$$

The British inch derived from this relation is 25.39998 millimeters (approx.).

From the above it is seen that the United States inch and the British inch differ by 0.00007 milli-

meter, or 0.0000028 inch, the United States inch being longer than the British inch by that amount.

Comparisons of the British Imperial Standard Yard with other standards over a period of many years have shown an apparent shortening of this standard, as compared with the International Meter. Some years ago the ratio was reported[4] as 3600/3937.0131, and more recently,[5] as 3600/3937.0147. This latest ratio gives to the British inch a length of 25.39996 mm, thereby increasing the difference between the United States and British inches to 0.00009 mm or about 0.0000036 in. The official relation of the British inch to the millimeter, however, has not been changed from that adopted in 1898.

Standard temperature of reference

Another practical difficulty which has stood in the way of complete agreement between measurements made in terms of the United States inch and those made in terms of the British inch, and which far outweighed that above referred to, was the fact that in the United States precision measurements of gages, machine parts, etc. were reduced to the basis of 68 F while similar measurements in Great Britain were reduced to the basis of 62 F.

Obviously if parts made in the United States had their dimensions correct at 68 F and similar parts made in Great Britain had their dimensions correct at 62 F, they would not interchange and fit properly, even though the basic definitions of the inch were identical. Parts that were correct at 62 F would be too large to interchange with similar parts that were correct at 68 F.

This difficulty has now been overcome and industrial standards, gages, etc., in both Great Britain and the United States are intended to have their nominal dimensions at 68 F. This important step having been taken by Great Britain, there is perhaps reason to hope that the two countries may also come to an agreement as to the exact definition of an inch and a yard that will be mutually satisfactory.

Recommended procedure

It would therefore seem wise to proceed along the following lines:

1. Accept the meter as being represented by 1,553,164.13 wave lengths of cadmium light, under standard conditions.
2. Define the yard as 0.9144 meter (or the inch as 25.4 millimeters).
3. Derive the number of wave lengths in the yard by multiplying the number contained in 1 meter by 0.9144.
4. Derive the number of wave lengths in the inch by dividing the number contained in the yard by 36.

The inch so derived would differ so little from those now in use in the United States and in Great Britain that the change would be detectable only in the most precise measurements. The United States inch would thereby be shortened from 25.40005 mm to 25.4 mm (exactly), and the British inch would be lengthened from 25.39998 mm (the official value), or from 25.39996 mm (the more precise present value) to 25.4 mm (exactly). It is seen that the proposed value of 25.4 mm is almost exactly half way between the present United States value and the present most precise British value. Could a happier solution be conceived?

So slight a change in the interest of international agreement should not shock the conscience of either country. Great Britain has already accepted 68 F as the temperature at which gages, machine parts, and industrial standards of length shall be correct, and if in addition both Great Britain and the United States adopt the above relation (1 yard = 0.9144 meter), the two great English-speaking countries will be on the same basis, and a very important step toward international standardization will have been taken.

Conclusion

In making the above proposals the desirability of obtaining agreement among the English-speaking nations has been emphasized. There is, however, no reason to delay action in the United States pending the establishment of such an agreement. The United States may well adopt the plan proposed in the expectation that its reasonableness and convenience will eventually bring about its acceptance elsewhere.

On the other hand, it would be rather unfortunate to establish a new value for the ratio of the inch to the millimeter without realizing that this involves a very small change in the inch (2 parts in 1,000,000). The proposal to establish the value 1 inch equals 25.4 millimeters as standard industrial practice should be approved. At the same time, however, steps should be taken to change the present legal equivalents accordingly.

Whether precise definitions in terms of wave lengths should be written into the statutes is doubtful. It would at least be wiser to await more definite international ratification of the numerical values before this is done.

[4] Glazebrook's Dictionary of Applied Physics, vol. 3, p. 593.
[5] Phil. Trans. Roy. Soc., vol. 227, p. 281.

ASA PROJECTS

A Review of Safety Code Projects Under ASA Procedure

The first of a series of reviews of standardization projects under the procedure of the American Standards Association

The status of all safety code projects under ASA procedure, except those relating to the mining and electrical fields, is summarized in the following review. The mining and electrical projects will be reviewed in later issues of INDUSTRIAL STANDARDIZATION. The data presented are taken from the files of the American Standards Association and are corrected to October 1, 1932, bringing up-to-date the review of safety code projects published in the November, 1931, issue.

A9-1929—Building Exits Code

Sponsor—National Fire Protection Association.

No new sections or revisions of existing sections have been developed during the past year. There have not been sufficient criticisms of the 1929 draft to warrant extensive revision of this code up to the present time.

A10—Safety Code for Construction Work

Sponsors—American Institute of Architects; National Safety Council.

The six subcommittees which were appointed about a year ago are now actively engaged in the preparation of drafts of the sections of the general code assigned to them. No reports have as yet been submitted to the sectional committee.

A11-1930—Code for Lighting: Factories, Mills and Other Work Places

Sponsor—Illuminating Engineering Society.

The revision of this code, which was approved as an American Standard in 1930, has been extensively distributed throughout the United States and copies have been sent to all regulatory bodies. The code contains a discussion of the necessity for good lighting as well as giving recommended values and minimum requirements for illumination for various classes of industrial buildings, work places, and for various operations.

A12-1932—Safety Code for Floor and Wall Openings, Railings and Toe Boards

Sponsor—National Safety Council.

A code prepared by the sectional committee was approved as American Standard on May 3, 1932. It is of fundamental importance in that it sets up, for the first time, national standards for railings and toe boards, and methods of protecting employees from accident through falling in or through floor and wall openings. Recognizing that the falls of persons are still one of the chief causes of accidents, a code of the type prepared by this sectional committee, if used extensively throughout the country, should do much toward the reduction of the number of accidents occurring from this cause.

A14-1923—Safety Code for the Construction, Care, and Use of Ladders

Sponsors—American Society of Safety Engineers, Engineering Section, National Safety Council.

A final draft of the revision of this code has been sent to the members of the sectional committee for letter ballot. All ballots, with the exception of two or three, have been received and efforts are now being made to iron out a few minor objections to particular sections of the code. It is expected that the code will be completed by the sectional committee, approved by the sponsor, and forwarded to the American Standards Association for approval within the next few months.

A17-1931—Safety Code for Elevators, Dumbwaiters and Escalators

Sponsors—American Institute of Architects; American Society of Mechanical Engineers.

As a supplement to the new Elevator Code, approved by the American Standards Association in July, 1931, a tentative draft of a Handbook for Inspectors has been prepared and distributed to all members of the sectional committee for criticism

and comment. This new standard will be of very great value to elevator inspectors and regulatory bodies, as well as to insurance companies, as a means of giving them additional information concerning the application of the provisions of the code to the different types of elevators they are called upon to inspect. Those who are interested in seeing a copy of this tentative draft should send their requests to Mr. J. A. Dickinson, Bureau of Standards, Washington, D. C., secretary of the sectional committee which prepared the Elevator Code.

A22—Safety Code for Walkway Surfaces

Sponsors—American Institute of Architects; American Society of Safety Engineers, Engineering Section, National Safety Council.

The special subcommittee charged with the development of the final draft now has before it a suggested draft on which to base its recommendations to the sectional committee. No final action by the subcommittee has as yet been taken.

A23-1932—Code for Lighting of School Buildings

Sponsors—Illuminating Engineering Society; American Institute of Architects.

This code was approved as American Standard in 1924. A revision was undertaken by the sectional committee in 1931 and was approved by the American Standards Association on September 15, 1932. The code now includes revised sections on Luminaires, Effect of Glare, and Color of Ceiling and Walls. This code is being printed by the sponsors and may be obtained from them or from the American Standards Association.

A39—Safety Code for Window Cleaning

Sponsor—National Safety Council.

A final draft of this code, prepared by the sectional committee, has been submitted by the sponsor for approval as American Recommended Practice. The code is now before the Safety Code Correlating Committee for recommendation to Standards Council on the question of its approval.

B7-1930—Safety Code for the Use, Care, and Protection of Abrasive Wheels

Sponsors—Grinding Wheel Manufacturers' Association of the United States and Canada; International Association of Industrial Accident Boards and Commissions.

A revision of this code is now in the hands of the sectional committee but has not as yet been approved by the American Standards Association. Since the new code was approved in June, 1930, two questions have been submitted to the sectional committee which will probably result in slight revisions.

B8-1932—Safety Code for the Protection of Industrial Workers in Foundries

Sponsors—American Foundrymen's Association; National Founders' Association.

The revision of this code was approved as American Standard on April 7, 1932. The new code has been widely distributed to foundries throughout the country and to all regulatory bodies. Copies may be obtained from the American Standards Association.

B9-1930—Safety Code for Mechanical Refrigeration

Sponsor—American Society of Refrigerating Engineers.

The sponsor has submitted for approval a revision of this code covering two new refrigerants. These revisions are now before Standards Council for approval. The refrigerants mentioned are methyl formate and dichlorodifluoromethane.

B11-1926—Safety Code for Power Presses and Foot and Hand Presses

Sponsor—National Safety Council.

This code was approved as an American Standard on November 11, 1926.

B13-1924—Logging and Sawmill Safety Code

Sponsor—U. S. Department of Commerce, Bureau of Standards.

This code was approved as an American Tentative Standard in January, 1924. The National Safety Council is now collecting material to be placed before the sectional committee in connection with a revision which will advance this code to a full American Standard.

B15-1927—Safety Code for Mechanical Power-Transmission Apparatus

Sponsors—American Society of Mechanical Engineers; International Association of Industrial Accident Boards and Commissions; National Bureau of Casualty and Surety Underwriters.

A general revision of this code is not being undertaken, but a new section on Mechanical Power Con-

trol has been before a special subcommittee for some time. Under present business conditions, however, it has not been possible to secure sufficient attendance to warrant calling a meeting of this subcommittee to complete the new section.

B19—Safety Code for Compressed Air Machinery

Sponsors—American Society of Mechanical Engineers; American Society of Safety Engineers, Engineering Section, National Safety Council.

During the past year there have been no meetings of the sectional committee and no new material has been prepared by the sponsors and sent to the sectional committee for consideration.

B20—Safety Code for Conveyors and Conveying Machinery

Sponsors—American Society of Mechanical Engineers; National Bureau of Casualty and Surety Underwriters.

The sectional committee has been actively at work on the preparation of drafts of various sections of this code since the work was initiated in 1925. A final draft of this code, however, has not been submitted to the sectional committee for letter ballot.

B24-1927—Safety Code for Forging and Hot Metal Stamping

Sponsors—American Drop Forging Institute; National Safety Council.

Work on this code was begun in 1923 and was completed and approved by the American Standards Association as an American Recommended Practice in April, 1927.

B28—Safety Code for Rubber Machinery

Sponsors—International Association of Industrial Accident Boards and Commissions; National Safety Council.

This committee is inactive. The Safety Code for Rubber Mills and Calenders (B28a) was approved as American Recommended Practice in 1927.

B30—Safety Code for Cranes, Derricks, and Hoists

Sponsors—American Society of Mechanical Engineers; U. S. Navy Department, Bureau of Yards and Docks.

A final draft of this code has been completed by the Editorial Subcommittee and has been submitted to the full membership of the sectional committee for their consideration.

D1-1925—Aeronautic Safety Code

Sponsor—Society of Automotive Engineers.

This code was approved as American Tentative Standard on December 7, 1925.

D2-1922—Automobile Headlighting

Sponsors—Illuminating Engineering Society; Society of Automotive Engineers.

There has been no activity during the past year on the part of the sponsors toward bringing about a revision of the code which was approved in 1922.

D3-1927—Colors for Traffic Signals

Sponsors—American Association of State Highway Officials; U. S. Department of Commerce, Bureau of Standards.

This code was approved as American Standard on November 15, 1927.

D4-1927—Safety Code for Brakes and Brake Testing

Sponsors—American Automobile Association; U. S. Department of Commerce, Bureau of Standards.

There has been no activity during the past year on the part of the sponsors toward bringing about a revision of the code.

D5—Manual on Street Traffic Signs, Signals, and Markings

Sponsor—American Engineering Council.

The sponsor has requested that action by the American Standards Association on this project be delayed due to the formation of a joint committee of the American Association of State Highway Officials and National Conference on Street and Highway Safety, to bring about the combination of the codes of the two organizations.

K2-1927—Gas Safety Code

Sponsors—American Gas Association; U. S. Department of Commerce, Bureau of Standards.

This code was approved as American Standard on December 28, 1925.

K13-1930—Safety Code for the Identification of Gas Mask Canisters

Sponsor—National Safety Council: Chemical Section, Mining Section, Petroleum Section, Public Utilities Section.

This code was approved as American Recom-

mended Practice in January, 1930. An informal suggestion was received from the German national standardizing body to the effect that it would be valuable if something could be done to correlate the code on this subject which they had prepared with that prepared under the procedure of the American Standards Association. This suggestion was referred to the sectional committee and was tentatively agreed to, with the additional suggestion that probably some of the other national bodies might like to join in this proposed effort. This has resulted in the suggestion being made to the International Standards Association that an international committee be appointed to correlate the work of the several national standardizing bodies which have prepared codes on this subject. No action has been taken, to date, on this suggestion.

L1-1929—Textile Safety Code

Sponsor—National Safety Council.

This code was approved as American Tentative Standard on October 11, 1929.

O1-1930—Safety Code for Woodworking Plants

Sponsors—International Association of Industrial Accident Boards and Commissions; National Bureau of Casualty and Surety Underwriters.

This code became an American Tentative Standard in 1924. Revision was undertaken in 1929 and the revised code was approved as American Standard in March 1930.

P1-1925—Safety Code for Paper and Pulp Mills

Sponsor—National Safety Council.

This code was approved as American Tentative Standard on January 8, 1925.

Z2-1922—National Safety Code for the Protection of the Heads and Eyes of Industrial Workers

Sponsor—U. S. Department of Commerce, Bureau of Standards.

This code was approved as American Recommended Practice in 1921 and advanced to an American Standard in October, 1922. The code was revised in 1928 and the scope enlarged to include gas masks and respirators, at which time the sectional committee was revised. Research work has been carried on by the Bureau of Mines, in reference to respirators and the sectional committee is waiting the final report on this work in order that a section on respirators may be added to the code. The Safety Code Correlating Committee has recommended to the sponsors that during the next revision of this project the subject of sand and abrasive blasting be considered very fully.

Z4—Safety Code for Industrial Sanitation

Sponsor—U. S. Treasury Department, Bureau of the Public Health Service.

A draft of this code was circulated by the sponsor for comment and criticism in September, 1932. A very widespread interest in the code has been evidenced as a result of the distribution of this draft and many criticisms have been submitted for consideration by the sectional committee. It is expected that this committee will meet within a very short time to take up its work actively on the development of the project.

Z5—Ventilation Code

Sponsor—American Society of Heating and Ventilating Engineers.

The sponsor for this code has recently submitted its own standard on Ventilating of Buildings as the basis of work for a sectional committee. While the project has been inactive for a number of years, the sponsor is now proceeding with the organization of a sectional committee and it is expected that the work will go forward promptly.

Z8-1924—Safety Code for Laundry Machinery and Operations

Sponsors—Association of Governmental Officials in Industry; Laundryowners National Association of the United States and Canada; National Association of Mutual Casualty Companies.

This code was approved as American Tentative Standard on June 4, 1924.

Z9—Safety Code for Exhaust Systems

Sponsor—(Unassigned).

In view of the relinquishing of sponsorship of this project by the American Society of Heating and Ventilating Engineers, the Safety Code Correlating Committee is considering the question of the assignment of new sponsors and of the development of plans for renewing activity to bring about the completion of the code.

Z12—Safety Codes for the Prevention of Dust Explosions

Sponsors—National Fire Protection Association; U. S. Department of Agriculture.

The permanent sectional committee in charge of the development of these codes began work in 1928 and to date has developed nine codes on the general subject of Dust Explosions as follows:

Z12a—Installation of Pulverized Fuel Systems. This code was originally approved on July 12, 1927. A revision was undertaken and approved on September 5, 1930.

Z12b—Installation of Pulverizing Systems for Sugar and Cocoa. This code was first approved November 4, 1927. A revision was approved September 24, 1931.

Z12c—Prevention of Dust Explosions in Starch Factories. This code was approved November 4, 1927. A revision was approved September 24, 1931.

Z12d—Prevention of Dust Explosions in Flour and Feed Mills. This code was approved January 12, 1928.

Z12e—Prevention of Dust Explosions in Terminal Grain Elevators. This code was approved January 12, 1928, and reapproved September 24, 1931, after revision.

Z12f—Prevention of Dust Explosions in Coal Pneumatic Cleaning Plants. Approved December 31, 1930.

Z12g—Prevention of Dust Explosions in Wood Flour Manufacturing Establishments. Approved September 24, 1931.

Z12h—Prevention of Dust Ignition in Spice Grinding Plants. Approved September 24, 1931.

Z12i—Use of Inert Gas for Fire and Explosion Prevention. Approved September 24, 1931.

Z13—Safety Code for Amusement Parks

Sponsors—National Association of Amusement Parks; National Bureau of Casualty and Surety Underwriters.

Many subcommittees have submitted drafts of various sections and these are being edited and correlated by the staff of the American Standards Association.

Z16—Standardization of Methods of Recording and Compiling Accident Statistics

Sponsors—International Association of Industrial Accident Boards and Commissions; National Council on Compensation Insurance; National Safety Council.

A final draft of Part I of this code covering Definitions and Rates was prepared as a result of a meeting of the sectional committee held on June 10 and 11, 1932. This draft has been submitted to the sectional committee for letter ballot but it is not likely that final action will be taken before another meeting of the sectional committee is held.

Z20—Safety Code for Grandstands

Various subcommittees have been appointed by the chairman of this sectional committee and are actively engaged in the preparation of drafts for consideration by the entire sectional committee.

Committees Report on Classification of Coals

A well attended meeting of the technical committees of the Sectional Committee on the Classification of Coals (M20) was held in Atlantic City, on October 10.

Reports of several subcommittees of the Technical Committee on the Scientific Classification of Coal indicated that marked progress was being made in setting up boundaries and specifications for different classes of coal. Subcommittee II on Origin, Composition, and Methods of Analysis of Coal, of which A. C. Fieldner[1] is chairman, submitted reports on "Recommendations on Testing Coal for Classification" and "Recommendations on Type Classification of Coal". Subcommittee IV on Tentative Classification of Coals, of which W. T. Thom, Jr.,[2] is chairman, submitted a report giving a tentative classification of North American coals by rank. All of these reports were accepted by the Committee for reference to the Technical Committee on Scientific Classification.

It was indicated that this technical committee will endeavor to submit a tentative system for classifying coals by rank and according to type at the next annual meeting of the sectional committee, which will be held in New York, in February, at the time of the meeting of the American Institute of Mining and Metallurgical Engineers.

[1] Chief Engineer, Experiments Stations Division, U. S. Bureau of Mines, Washington, D. C.

[2] Princeton University, Princeton, N. J.

General Conference Recommends Standard Inch-Millimeter Conversion Ratio

An American Standard value to be used by industry in converting inches to millimeters was recommended by a general conference held under the auspices of the American Standards Association on October 21, following a request of the Ford Motor Company. Representatives of 18 industrial groups having an interest in precise measurements and methods of limit gaging were present. The conference unanimously recommended the conversion factor of one inch equals 25.4 millimeters to become the American Standard value for industrial use, replacing for this purpose both the official ratio 25.40005 and the rounded value 25.4001 given in certain handbooks and tables.

The official British ratio is 25.399978, and the last precise experimentally determined value 25.399956. Thus the British official value is about one part in a million below, and the American official value about two parts in a million above 25.4. British industry through the British Standards Institution, adopted the value 25.4 for industrial use in 1930. This simple ratio has been advocated by Continental European countries.

The adoption of the conversion ratio 25.4 by American industry will secure world-wide uniformity in conversion practice. For example, an American automobile manufacturer having plants in both metric and inch countries desiring to have complete interchangeability of parts regardless of the country in which they are made, can use identical blueprints in the respective countries on the basis of the uniform conversion ratio 25.4.

The matter is also of importance on account of the fact that the ultimate check on the accuracy of workshop and inspection gages used in manufacturing practice is made by means of highly accurate reference gage blocks held within a tolerance of a few millionths of an inch per inch.

The conference was presided over by P. G. Agnew, secretary, American Standards Association, and was attended by Dr. Lyman J. Briggs, Acting Director, National Bureau of Standards; H. W. Bearce, Co-Chief, Division of Weights and Measures, National Bureau of Standards; E. G. Liebold, Ford Motor Company; C. E. Johansson, gage manufacturer, associated with the Ford Motor Company; and representatives of the American Gear Manufacturers Association, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Society of Swedish Engineers, the American Telephone and Telegraph Company, Bell Telephone Laboratories, Brown & Sharpe Manufacturing Company, General Electric Company, the Gage Manufacturers Association, Metal Cutting Tool Institute, National Electrical

C. E. Johansson holding the apparatus with which differences of a few millionths of an inch in length are made perceptible to the touch. Mr. Johansson demonstrated the apparatus before the Conference on Inch-Millimeter Conversion.

Manufacturers Association, National Machine Tool Builders Association, Navy Department-Bureau of Construction and Repair, Baush & Lomb Optical Company, Society of Automotive Engineers, the Manufacturers' Standardization Society of the Valve and Fittings Industry, Western Electric Company.

Mr. Johansson gave a demonstration showing, by means of a set of highly accurate gage blocks, the extremely slight difference of two millionths of an inch per inch involved in the change under consideration—just barely perceptible to the touch.

The recommendation adopted by the conference will be sent by the American Standards Association to all industrial groups concerned for written acceptance before final approval as an American Standard is given by ASA.

American Standard Forms for Concrete Construction Floors

A new American Standard on Forms for Concrete Joist Construction Floors (A48-1932) has been approved by the American Standards Association. It covers the main dimensions of removable and permanent forms, pans, or domes made of wood, steel, or other material used in concrete ribbed floor construction.

The standard is a revision of Simplified Practice Recommendation R87-31.

The new standard was submitted to the American Standards Association by the Concrete Reinforcing Steel Institute and the National Bureau of Standards as an existing standard. It may be purchased from ASA at five cents per copy.

ASA Approves Standard on Air Cylinders and Adapters

An important new American Standard on Rotating Air Cylinders and Adapters (B5.5-1932) has been approved by the American Standards Association. It was developed by technical committee 11 on Chucks and Chuck Jaws, of the Sectional Committee on Small Tools and Machine Tool Elements (B5), working under the sponsorship of the American Society of Mechanical Engineers, the National Machine Tool Builders' Association, and the Society of Automotive Engineers. J. E. Lovely, chief engineer, Jones and Lamson Company, Springfield, Vermont, is chairman of technical committee 11 on Chucks and Chuck Jaws.

The standard has been developed to obtain interchangeability of different makes of air cylinders on the spindles of machine tools without changing the adapter or draw rod.

Three sizes of standard adapters cover the range of standard air cylinders from 3 inches to 18 inches inclusive. Adapter "A" fits the 3-inch and 4½-inch cylinders; adapter "B" fits the 6-inch and 8-inch cylinders; and adapter "C" fits all sizes of cylinders from the 10-inch to 18-inch inclusive. A fourth size, adapter "D", is also included and is provided to accommodate the 20-inch air cylinder or other power-operated devices having a draw rod pull of 26,000 to 40,000 pounds.

The length of stroke of the standard cylinders, the position of the piston rod at the end of the stroke, and the diameter of the tapped hole in the piston rod have also been standardized so that air cylinder draw rods do not have to be fitted to individual air cylinders.

In order to allow the use of air cylinders on spindles with comparatively small holes, the diameters of the piston rods are as small as is consistent with the requisite strength.

The piston rods and adapters of this standard have been designed to withstand stress resulting from air pressures up to 100 lb per sq in. It is intended, however, that these pistons and adapters may be applied to hydraulic cylinders or to other mechanical operating devices which do not develop working stresses in excess of those developed by the corresponding sizes of air cylinders.

A.S.T.M. Committee Reports on Electrical Insulating Materials

The report of its Committee D-9 on Electrical Insulating Materials, entitled *Methods of Test Relating to Electrical Insulating Materials,* has been published by the American Society for Testing Materials. The book contains all of the Society's standards on electrical insulating materials, as well as a summary of recent activities of the committee. Twenty-nine standards are included, of which ten are specifications for rubber and textile products used in the electrical industry, and 19 are standard methods of test.

The book may be purchased from the American Society for Testing Materials, 1315 Spruce Street, Philadelphia, or from the American Standards Association, at $1.25 per copy.

Supplement to A.S.T.M. Book of Standards

The American Society for Testing Materials has recently issued a 1932 supplement to the 1930 edition of its *Book of Standards.* The supplement contains seven new standards recently adopted by the Society together with a complete list of all A.S.T.M. standards and tentative standards. Copies of the supplement may be purchased from the American Society for Testing Materials, 1315 Spruce Street, Philadelphia, or from the American Standards Association at $1.50 per copy.

Methods of Testing Petroleum Products and Lubricants

by
R. P. Anderson,[1] *Secretary*
A.S.T.M. Committee on
Petroleum Products

From the early days of petroleum refining, laboratory tests have played an important role in the control of refinery operations and in determining the quality of the finished products.

Laboratory tests were first developed by individual refiners as required in their own operations. As the industry grew and commerce in finished products in bulk became increasingly important, the need for uniformity in the necessary laboratory tests became obvious. The first step toward this uniformity lay in the creation in 1904 of Committee N on Standard Tests for Lubricants of the American Society for Testing Materials. In 1910, the designation was changed from N to D-2, and in 1919 the scope of the committee was broadened and the name changed to the now well-known Committee on Petroleum Products and Lubricants.

Committee D-2 on Petroleum Products and Lubricants has grown to be one of the largest and most active committees of the American Society for Testing Materials. It has 112 members and is thoroughly representative of the refining branch of the petroleum industry, the large users of petroleum products, and the various government departments that are interested in petroleum products.

In 1926 ASA Committee Z11 on Methods of Testing Petroleum Products and Lubricants was organized under the sponsorship of the American Society for Testing Materials. This committee is identical in personnel with Committee D-2, but differs in form of organization in that various associations interested in petroleum testing are officially represented on the committee.

Committee Z11 has recommended from time to time various of the A.S.T.M. Standards developed under the jurisdiction of Committee D-2 for the approval of the American Standards Association. There are now 24 American Standards and 6 American Tentative Standards pertaining to the testing of petroleum products and lubricants, including the newly approved standard methods listed on the following pages. These methods are generally specified in this country whenever petroleum products are bought or sold on specification, and are considered as referee tests.

A peculiarity of many of the methods of test for petroleum is that all of the details of the method must be carefully and accurately followed if the results are to be of value. A convenient illustration is the distillation of gasoline by Method Z11.10-1930—Method of Test for Distillation of Gasoline, Naphtha, Kerosine, and Similar Petroleum Products (A.S.T.M. D 86-30). Performing a distillation test on a commercially pure chemical substance is a simple matter, but in the case of a complex mixture like gasoline, the data obtained would vary considerably with relatively minor changes in the method. Consequently, it is imperative to carry out the test in strict accordance with the standard procedure if specifications are to be met or if data of value for correlative purposes are to be obtained. Fortunately this is a requirement that is generally quite fully appreciated and the widespread use of these standard methods has eliminated most of the difficulties that have arisen in the past through use of local variations in test procedure.

Internationally but little progress has as yet been made in arriving at uniform testing methods, and there are serious difficulties in the way of progress in this field. For years there has been close cooperation between A.S.T.M. Committee D-2 and the Standardization Committee of The Institution of Petroleum Technologists of England, with the result that many of the English methods are essentially in agreement with the American methods.

There is now in course of organization, under the auspices of the International Standards Association, ISA Technical Committee 28 on Nomenclature and Methods of Testing Petroleum Products and Lubricants, with representatives from various national standardizing bodies. The function of this committee is to arrange for interchange of information about the testing methods in each country, which it is hoped will eventually lead to a greater degree of uniformity throughout the world.

[1] Secretary of Committee Z11 under ASA procedure.

ASA Approves Standard Tests for Petroleum

The American Standards Association has approved two new American Standards and four American Tentative Standards for Methods of Testing Petroleum Products and Lubricants, and has also approved the revision of an existing American Standard, and the advancement of four American Tentative Standards to the status of American Standard. This action followed the endorsement and submittal to ASA by the sponsor (the American Society for Testing Materials) of recommendations from the Sectional Committee on Methods of Testing Petroleum Products and Lubricants (Z11) concerning standards developed by A.S.T.M. Committee D-2. This A.S.T.M. committee is identical in title and personnel with the sectional committee.

The following were approved as American Standards:

Carbon Residue of Petroleum Products (Conradson Carbon Residue) (A.S.T.M. D 189-30) approved with the ASA designation Z11.25-1932

Testing Gas Oils (Gravity, Distillation, Sulfur, Carbon Residue, Pour Point, Viscosity, Water) (A.S.T.M. D 158-28) approved with the ASA designation Z11.26-1932

The titles of the approved American Tentative Standards are:

Expressible Oil and Moisture in Paraffin Waxes (A.S.T.M. D 308-29 T), approved with the ASA designation Z11.27-1932

Definitions of Terms Relating to Petroleum (A.S.T.M. D 288-30 T), approved with the ASA designation Z11.28-1932

Dilution of Crankcase Oils (A.S.T.M. D 322-30 T), approved with the ASA designation Z11.29-1932

Precipitation Number of Lubricating Oils (A.S.T.M. D 91-30 T), approved with the ASA designation Z11.30-1932

The title of the American Standard Method of Test for Distillation of Natural Gas Gasoline (Z11k-1930), which is A.S.T.M. standard D 216-1930, was revised to read: Method of Test for Distillation of Natural Gasoline (Z11.11-1932). Other revisions in this standard are confined to certain changes in the text to clarify the procedure and eliminate a form for recording data, and to editorial changes in the text.

The following American Tentative Standards were advanced to the status of American Standard:

Method of Test for Cloud and Pour Points of Petroleum Products (Z11e-1930), which now has the ASA designation Z11.5-1932

Method of Test for Melting Point of Petrolatum (Z11v-1930), new ASA designation Z11.22-1932

Determination of Autogenous Ignition Temperatures (Z11w-1930), new ASA designation Z11.23-1932

Flash Point of Volatile Flammable Liquids (K8-1923), new ASA designation Z11.24-1932

These American Standards are A.S.T.M. standards D 97-30, D 127-30, D 286-30, and D 56-21, respectively.

In connection with the advancement of these standards to American Standards, a minor revision, editorial in character, was made in one section of the standard Method of Test for Cloud and Pour Points (Z11.5-1932).

Copies of the recently approved standards are available from the American Society for Testing Materials or from the ASA office at 25 cents each.

The American Society for Testing Materials has recently published the *Report of Committee D-2 on Petroleum Products and Lubricants and Methods of Test Relating to Petroleum Products* which includes, among the 48 standards published in the volume, the 30 methods of test for petroleum products and lubricants which have been approved by the American Standards Association. Among these are the six recently adopted standards.

The report, a volume of 286 pages, covers the activities of Committee D-2 for the past year as well as including the complete text of the standards for testing petroleum and its products. Of the 48 standard methods of test published, 33 have been adopted by the A.S.T.M. as standard and 15 as tentative standard. Three American Standards for testing bituminous materials, as well as the A.S.T.M. standards or tentative standards for testing bituminous materials and electrical insulating oils, are also included in the report.

A facsimile of the recently published A.S.T.M. Viscosity-Temperature Chart, together with directions and suggestions for its use, is published in the report.

Copies of the report may be purchased from the American Society for Testing Materials, 1315 Spruce Street, Philadelphia, or may be purchased or borrowed from the American Standards Association. The price is $1.25 per copy.